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Systematic Review and Meta-analysis of Self-Determination Theory-Based Interventions in Mental Health

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The authors declare that there are no conflicts of interest.

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Data Availability

All data used in this review are derived from previously published studies. Extracted datasets, coding files, and analytic scripts are available in the public domain via the Open Science Framework (OSF) at: https://osf.io/zm29t/overview?view_only=ee16d181b5874da68b4fcc01e3c5b0b7).

Transparency Statement

The authors affirm that this manuscript is an honest, accurate, and transparent account of the study conducted and that no important aspects of the research have been omitted. The review adheres to PRISMA 2020 guidelines and fully reports all methodological and analytic decisions.

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Abstract

Background: Self-Determination Theory (SDT) proposes that satisfaction of the basic psychological needs for autonomy, competence, and relatedness promotes psychological growth and mental health. However, previous evidence syntheses have largely examined psychopathology or well-being separately. The present systematic review and meta-analysis evaluated the effects of SDT-based interventions on mental health while separately examining mental illness outcomes and positive mental health (psychological functioning) within Keyes' dual-continua framework.

Methods: A systematic review and meta-analysis of 43 experimental and quasi-experimental studies was conducted. Random-effects meta-analyses estimated pooled intervention effects using study-level composite effect sizes for mental illness and positive mental health outcomes, while narrative synthesis summarized need-supportive intervention techniques. Moderator analyses examined participant, methodological, and intervention characteristics.

Results: SDT-based interventions demonstrated a large overall effect on mental health ($g = 2.51$). Separate analyses based on Keyes' dual-continua model indicated large effects for both mental illness reduction ($g = 2.55$) and positive mental health (psychological functioning; $g = 2.48$). Moderator analyses did not identify statistically significant differences according to participant, methodological, or intervention characteristics. Substantial between-study heterogeneity remained, warranting cautious interpretation of the pooled estimates.

Conclusions: SDT-based interventions may promote holistic mental health by reducing mental illness outcomes while enhancing positive mental health (psychological functioning). Integrating these outcomes within Keyes' dual-continua model extends previous SDT evidence syntheses and highlights the potential of SDT as a theoretically grounded framework for promoting both recovery from psychological distress and positive psychological functioning.

Key words: Self-Determination Theory; Psychological Well-Being; Mental Health; Motivation; Psychological Interventions; Meta-Analysis

1.0 Introduction

Mental disorders are among the leading contributors to disability worldwide and impose substantial personal, social, and economic burdens (Vigo et al., 2016). Although psychological interventions have traditionally been evaluated primarily through symptom reduction, contemporary perspectives emphasize that mental health involves more than the absence of psychopathology. It also includes positive psychological functioning, well-being, and the capacity to flourish (Keyes, 2002; Westerhof & Keyes, 2010).

Keyes' (2002) dual-continua model provides an overarching framework for understanding mental health as comprising two related but distinct dimensions: mental illness and positive mental health. Mental illness was conceptualized in the present review as the severity of psychological symptoms, including depression, anxiety, stress, post-traumatic stress, and general psychological distress. These outcomes were assessed through symptom-based measures such as the Beck Depression Inventory, Beck Anxiety Inventory, Depression Anxiety Stress Scales, Patient Health Questionnaire, Center for Epidemiologic Studies Depression Scale, and Kessler Psychological Distress Scale (Beck et al., 1988; Kessler et al., 2002; Kroenke et al., 2001; Lovibond & Lovibond, 1995; Radloff, 1977). Thus, this domain reflected the intensity of psychological symptoms rather than solely the presence or absence of a formal psychiatric diagnosis.

Positive mental health, referred to in this review as positive psychological functioning, was conceptualized as the presence of adaptive emotional, psychological, and social functioning. It included indicators such as life satisfaction, flourishing, positive affect, psychological well-being, social well-being, subjective vitality, meaning in life, hope, and general mental well-being. This conceptualization is consistent with Keyes' (2002, 2005) model and broader theories of psychological well-being, which emphasize autonomy, personal growth, positive relationships, purpose in life, environmental mastery, and self-acceptance (Diener et al., 2010; Ryff, 1989; Ryff & Keyes, 1995). Therefore, positive mental health represented the presence of well-being and adaptive functioning rather than merely the absence of psychological symptoms.

Accordingly, the present review operationalized mental illness outcomes through continuous scores reflecting psychological symptoms, with higher scores generally indicating greater distress or psychopathology. Positive mental health outcomes were operationalized through continuous scores reflecting well-being, flourishing, life satisfaction, vitality, meaning, hope, and adaptive psychological functioning. Overall mental health was examined by synthesizing relevant effects across both domains while retaining separate estimates for mental illness and positive mental health outcomes.

Self-Determination Theory (SDT; Deci & Ryan, 2000) provides a complementary framework for explaining these outcomes. Satisfaction of autonomy, competence, and relatedness is theorized to promote autonomous motivation, vitality, psychological growth, and well-being, whereas need frustration may contribute to distress and maladjustment (Ryan & Deci, 2020; Ryan et al., 2022). Consequently, the present review examined whether SDT-based interventions reduced psychological symptoms, enhanced positive psychological functioning, or achieved both outcomes. This approach applies the dual-continua model while providing a clearer operational distinction between mental illness and positive mental health (Franken et al., 2018; Westerhof & Keyes, 2010).

A substantial body of research has examined SDT across clinical and non-clinical contexts. However, existing studies vary in their theoretical focus, populations, intervention settings, outcome domains, and methodological designs. These differences make it difficult to draw general conclusions about the effectiveness of SDT-based interventions for mental health. Furthermore, few syntheses have simultaneously considered mental illness and positive mental

health while examining the SDT domains, intervention techniques, and contextual factors that may influence intervention effectiveness (Ryan et al., 2022).

1.1 Previous Meta-Analytic Evidence and Research Gaps

Previous meta-analytic evidence can be broadly organized according to Keyes' dual-continua framework. In health-related contexts, Ng et al. (2012) found that autonomy support and satisfaction of the basic psychological needs were associated with favourable health and psychological outcomes. Similarly, Gillison et al. (2019) and Sheeran et al. (2020) reported that SDT-informed interventions improved need satisfaction, autonomous motivation, health-related behaviours, and selected psychological outcomes. However, mental illness outcomes were often secondary outcomes within broader health-behaviour interventions, and several reviews included substantial correlational evidence. Thus, the specific effectiveness of SDT-based interventions for mental illness remains unclear.

Another body of research has focused on positive mental health and psychological functioning. Vite et al. (2024) found that autonomy satisfaction was positively associated with well-being and negatively associated with ill-being among school-aged youth. Similarly, Wang et al. (2024) reported that SDT-based interventions in educational settings improved students' motivation and psychological need satisfaction, while Howard et al. (2024) demonstrated that need-supportive environments were associated with more adaptive functioning and that need-thwarting environments were related to poorer outcomes. Nevertheless, these syntheses largely focused on educational, motivational, or academic outcomes and frequently included correlational evidence. Their findings therefore provide indirect rather than definitive evidence of intervention effects on positive mental health.

Broader syntheses have also supported the applicability of SDT across contexts. Ryan et al. (2022), in a meta-review covering healthcare, education, parenting, organizations, and sport, concluded that satisfaction of autonomy, competence, and relatedness consistently promotes motivation and well-being, whereas frustration of these needs predicts ill-being and maladjustment. However, the inclusion of diverse populations, study designs, and outcome domains limited the ability of this review to estimate the effects of SDT-based interventions specifically on mental health or to identify the intervention components responsible for positive outcomes.

Several gaps consequently remain. Previous meta-analyses have emphasized health behaviours, motivation, education, or general well-being, while mental health outcomes have received less focused attention. Although the dual-continua model has received considerable empirical support, few reviews have applied it directly to SDT-based interventions by

distinguishing mental illness from positive mental health and examining their combined contribution to overall mental health (Iasiello et al., 2020). Moreover, the relative roles of autonomy, competence, relatedness, and intrinsic motivation remain uncertain, as do the effects of specific need-supportive techniques. Limited evidence also exists regarding variation in outcomes according to participant characteristics, cultural context, study design, intervention format, intensity, delivery mode, or provider.

The present systematic review and meta-analysis addresses these limitations by synthesizing experimental and quasi-experimental studies of SDT-based interventions among adolescents and adults. Guided by Keyes' dual-continua model, it evaluates effects on overall mental health while separately examining mental illness and positive mental health outcomes. It also investigates individual SDT domains, need-supportive intervention techniques, and moderators related to participants, methodology, intervention characteristics, and cultural context. Based on SDT and the dual-continua model, it was hypothesized that SDT-based interventions would improve overall mental health by reducing mental illness outcomes and enhancing positive psychological functioning.

The present review makes several contributions to the existing literature. By integrating SDT with Keyes' (2002) dual-continua model, it examines SDT-based interventions across both mental illness and positive mental health (psychological functioning), extending previous syntheses that have largely focused on health behaviours, motivation, or well-being separately (Ng et al., 2012; Ntoumanis et al., 2021; Ryan et al., 2022). It further synthesizes the need-supportive techniques employed across interventions and examines participant, methodological, intervention, and cultural characteristics that may influence intervention effects. These contributions may help clarify the relevance of SDT as a framework for holistic mental health and inform interventions that extend beyond symptom reduction to support positive psychological functioning through autonomy-, competence-, and relatedness-supportive strategies (Ryan & Deci, 2017, 2020; Teixeira et al., 2020). The theoretical and clinical/practical implications of these findings are discussed in greater detail in the Discussion.

2. Methods

2.1 Review Protocol Registration and Reporting Guidelines

The protocol details were deposited in the Open Science Framework (osf.io/4gg6v) through Review Commons that adhered to registered guidelines. The systematic review and meta-analysis was prespecified in PROSPERO (International Prospective Register of Systematic Reviews; CRD420251165636, registered on 20 October 2025). The review followed the methodological advice offered in the Cochrane Handbook for Systematic Reviews of Interventions (version 6.4; Higgins et al., 2023), and reported using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020). All scripts for data extraction, coding manuals, and analytic scripts are available on the Open Science Framework to ensure transparency and replicability.

2.2 Search Strategy

A comprehensive literature search was conducted across ProQuest, PubMed, and Scopus from database inception until the final search date using a predefined search strategy developed in accordance with the review objectives. The search combined controlled vocabulary (where available) and free-text keywords related to SDT, SDT-based interventions, and mental health outcomes. Consistent with Keyes' dual-continua conceptualization of mental health, the search strategy incorporated terms representing both mental illness outcomes (e.g., depression, anxiety, stress, psychological distress, mental disorders) and positive mental health (psychological functioning) outcomes (e.g., psychological well-being, flourishing, resilience, happiness, life satisfaction, and positive mental health).

The complete electronic search strategy for each database is provided in the Supplementary file available through the **Open Science Framework (OSF) repository (File name: Supplementary file)** (https://osf.io/zm29t/overview?view_only=ee16d181b5874da68b4fcc01e3c5b0b7).

2.3 Procedure

The studies were included for full-text review if the intervention was based on SDT, at least one mental health variable was measured, and the participants/ recipients of the therapy were either adolescents (aged 10 and above) (Sawyer et al., 2018) or adults (aged below 60 years). Studies were excluded if the participants were children or the elderly, and if the study design was observational. The screening was conducted with the help of the COVIDENCE software, in which 686 duplicates were removed, and 2203 studies were screened. After the screening, 56 studies were included for full-text review. However, due to insufficient data reported in the article or due to methodological issues where the intervention group and control group were similar, around 13 studies were excluded. The final synthesis consisted of 43 studies after the exclusion (See Figure 1). Screening and data extraction was done by a single reviewer and later verified by the remaining two reviewers to ensure validity. The disagreements between the two reviewers were resolved through discussions as almost all decisions were unanimous. The reviewer attempted to contact the study authors for more information; however, only one author provided the necessary data, while one author denied access to data due to confidentiality issues, and the remaining authors failed to respond.

Figure 1: PRISMA flow diagram of study selection

(Insert Figure 1 here)

2.4 Data Extraction

A standardized data extraction form was developed to systematically record study characteristics relevant to the objectives of the review. Extracted information included: (a) methodological characteristics (study design, sample size, participant characteristics, control

condition, randomization procedures, follow-up duration, and outcome measures); (b) intervention characteristics (setting, intervention provider, delivery mode, intervention format, intervention intensity, duration, and implementation fidelity where reported); and (c) theoretical characteristics (SDT domains targeted, autonomy-, competence-, and relatedness-supportive techniques employed, and other motivational strategies incorporated within the intervention).

The coding framework was initially developed by the corresponding author (N.N.S.) following recommendations from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2023), the meta-analytic procedures described by Lipsey and Wilson (2001), and coding frameworks adopted in previous SDT systematic reviews and meta-analyses (e.g., Teixeira et al., 2020). The framework was subsequently reviewed and refined collaboratively by all authors to ensure conceptual consistency and alignment with the study objectives. The final extraction template was piloted on a subset of eligible studies to assess clarity, feasibility, and inter-rater agreement before full implementation.

All eligible studies were initially coded by the first author (S.P.S.) using the finalized coding framework. Coding decisions were subsequently reviewed by the research team, and any discrepancies were resolved through discussion until consensus was achieved. When essential methodological or statistical information was unavailable, corresponding authors were contacted to obtain clarification or additional data where feasible.

2.5 Quality Assessment

Methodological quality was evaluated using the Revised Cochrane Risk of Bias Tool for Randomized Trials (RoB 2) (Sterne et al., 2019) for randomized controlled trials and the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) (Sterne et al., 2016) for quasi-experimental studies. Risk-of-bias assessments were conducted independently by two reviewers, with disagreements resolved through discussion and consensus.

Risk-of-bias ratings were used to characterize the methodological quality of the included studies and to inform the sensitivity analyses undertaken in the present review. A detailed description of the coding framework, extracted variables, and quality assessment procedures is publicly available through the OSF repository (**File name: Data extraction form; Copy of DATA EXTRACTION SDT META ANALYSIS 2025 (Responses)**). (https://osf.io/zm29t/overview?view_only=ee16d181b5874da68b4fcc01e3c5b0b7).

2.6 Outcome Classification and Data Extraction

To ensure conceptual consistency across the diverse outcome measures reported in the included studies, mental health outcomes were classified *a priori* within Keyes' (2002) dual-continua framework, which conceptualizes mental illness and positive mental health as related but distinct dimensions. Accordingly, outcomes were grouped into two overarching domains: (a) mental illness outcomes, reflecting symptoms of psychopathology and

psychological distress, and (b) positive mental health outcomes (positive psychological functioning), reflecting emotional, psychological, and social well-being and related indicators of adaptive functioning (Keyes, 2002; Westerhof & Keyes, 2010). This distinction is also consistent with the broader conceptualization of mental health as extending beyond the absence of mental illness to include well-being and effective functioning (World Health Organization, 2022).

Mental illness outcomes included depression, anxiety, perceived stress, general psychological distress, post-traumatic stress symptoms, and related psychological or behavioural dysfunction. Measures assessing depressive, anxiety, stress, trauma-related, non-specific distress, and broader psychological or behavioural difficulties were classified within this domain according to the primary construct and interpretation of the outcome in the original study (Beck et al., 1988; Kessler et al., 2002; Kroenke et al., 2001; Lovibond & Lovibond, 1995; Radloff, 1977).

Positive mental health (positive psychological functioning) primarily encompassed indicators of emotional, psychological, and social well-being. Core indicators included flourishing, life satisfaction, happiness, positive affect, psychological well-being, and social well-being (Diener et al., 2010; Keyes, 2002; Ryff, 1989; Ryff & Keyes, 1995). Other positively oriented outcomes reported in the included studies—including subjective vitality, hope, meaning in life, self-efficacy, social functioning, and quality of life—were classified within the broader positive psychological functioning domain when they reflected adaptive functioning rather than symptoms of psychopathology. These broader indicators were not considered core components of Keyes' model but were included based on their conceptualization as indicators of positive or adaptive psychological functioning.

Operational definitions of each outcome construct, their classification within the two overarching domains, the psychometric measures used to assess them, and the basis for their classification are provided in Supplementary Table S2.

This classification enabled outcomes assessed using diverse psychometric instruments to be synthesized within a common conceptual framework while preserving the distinction between mental illness and positive mental health. For quantitative synthesis, effect sizes were harmonized so that positive values consistently represented improved mental health, either through reductions in mental illness symptoms or improvements in positive psychological functioning.

2.7 Data Analysis

2.7.1 Narrative Synthesis

Narrative synthesis was undertaken for aspects of the review that were not amenable to quantitative pooling, particularly the characterization of SDT domains, need-supportive intervention techniques, and implementation characteristics across studies. Intervention techniques were synthesized using the Theory Coding Scheme (TCS) (Michie & Prestwich,

2010) to identify the theoretical components employed to support autonomy, competence, relatedness, and intrinsic motivation. In addition, methodological characteristics, intervention features, and implementation strategies associated with SDT-based interventions were descriptively summarized to complement the quantitative findings.

2.7.2 Meta-analysis

Quantitative analyses were performed using Comprehensive Meta-Analysis (CMA) software. A random-effects model was employed to estimate pooled effect sizes, acknowledging the expected heterogeneity arising from differences in participant characteristics, intervention content, and study methodologies. Standardized mean differences (Hedges' g) were calculated to facilitate comparison across studies employing diverse psychometric instruments.

Consistent with Keyes' dual-continua conceptualization of mental health, outcome measures were harmonized such that positive effect sizes uniformly reflected improved mental health. Accordingly, effect sizes derived from mental illness outcomes (e.g., depression, anxiety, stress, psychological distress and etc), where lower scores indicate improvement, were directionally reversed, whereas effect sizes derived from positive mental health (psychological functioning) outcomes (e.g., flourishing, psychological well-being, life satisfaction, subjective vitality, and related constructs), where higher scores indicate improvement, retained their original direction.

Because several studies reported multiple outcome measures assessing the same underlying construct, study-level composite effect sizes were computed to preserve statistical independence and avoid double-counting participants. Combining multiple correlated outcomes into a single synthetic effect size is a recommended meta-analytic approach when outcomes represent the same conceptual construct, as it minimizes unit-of-analysis errors while retaining information from all eligible outcome measures (Borenstein et al., 2021; Higgins et al., 2024). Specifically, all eligible mental illness outcomes reported within an individual study were combined into a single composite effect size representing the mental illness construct, while all eligible positive mental health (psychological functioning) outcomes were similarly combined into a single composite effect size representing positive mental health. Consequently, each study contributed a maximum of two independent effect sizes (one for mental illness and one for positive mental health) to the primary meta-analysis.

Separate random-effects meta-analyses were subsequently conducted for mental illness outcomes and positive mental health (psychological functioning) outcomes, followed by an overall pooled analysis of the composite effect sizes. Statistical heterogeneity was evaluated using Cochran's Q statistic and prediction intervals. Moderator analyses were performed using the composite dataset to examine participant characteristics (age and country), methodological characteristics (study design), and intervention characteristics (format, delivery mode, and intervention intensity).

As the computation of composite effect sizes aggregated individual psychological constructs into broader mental illness and positive mental health domains, moderator analyses involving

SDT domains (autonomy, competence, and relatedness) and intrinsic motivation could not be performed using the composite dataset. Therefore, these theory-driven analyses were conducted separately using the original outcome-level dataset, in which individual outcomes were retained. These analyses were intended to provide theoretical insight into SDT processes and should be interpreted as exploratory rather than definitive estimates of differential intervention effectiveness.

Sensitivity analyses excluding studies with elevated risk of bias were undertaken to examine the robustness of the findings. Publication bias was assessed using Egger's regression test and Duval and Tweedie's trim-and-fill procedure.

3. Results

3.1 Characteristics of Included Studies

Study and Participant Characteristics

The review included 43 intervention studies comprising 23 randomized experimental studies and 20 quasi-experimental studies conducted across schools, community settings, healthcare centres, universities, and other community-based contexts (see Table 1). A total of 7,362 participants were included, of whom 3,693 received SDT-based interventions and 3,669 served as controls. Across studies, 2,948 participants were male and 4,414 were female. The majority of studies were conducted in Western, Educated, Industrialized, Rich and Democratic (WEIRD; Beyebach et al., 2021) countries ($n = 34$), while nine studies originated from non-WEIRD countries. Participants included both adolescents (11 studies) and adults (31 studies).

(Insert Table 1)

Intervention Characteristics

SDT interventions demonstrated considerable variation in their implementation characteristics (Table 2). Twenty-three interventions were delivered directly by researchers, whereas twenty interventions were delivered by trained professionals, teachers, peers, or facilitators. Twenty studies employed individual formats, twenty-two employed group formats, and one combined both approaches. Most interventions were delivered face-to-face (30 studies), while eleven were delivered online and two adopted blended delivery.

Intervention intensity was categorized as low (<5 sessions), moderate (6–14 sessions), and high (>14 sessions), with 14, 16, and 13 studies falling within these respective categories. Across studies, interventions primarily targeted satisfaction of the three basic psychological needs (autonomy, competence, and relatedness), whereas relatively few interventions focused exclusively on autonomy or intrinsic motivation.

3.2 Narrative Synthesis of SDT Intervention Techniques

To better understand how SDT principles were operationalized, intervention techniques were coded according to the taxonomy proposed by Teixeira et al. (2020) (see Table 2). Across studies, autonomy-supportive techniques most frequently included providing meaningful rationales, offering behavioural choice, and encouraging self-initiation. Competence-supportive strategies commonly involved setting optimal challenges, providing constructive feedback, and facilitating action planning, whereas relatedness-supportive techniques frequently emphasized demonstrating genuine interest, providing ongoing support, and acknowledging participants' perspectives and feelings. These findings indicate that SDT interventions generally targeted multiple psychological needs simultaneously rather than relying on isolated motivational strategies.

(Insert Table 2)

3.3 Meta-analysis of Overall Mental Health Outcomes

A random-effects meta-analysis including 43 studies demonstrated a statistically significant overall effect of SDT-based interventions on mental health, yielding a large pooled effect size ($g = 2.51$, 95% CI 1.83–3.18; see Table 3). Significant heterogeneity was observed (Q test, $p < .001$; $I^2 = 86\%$), with a wide prediction interval (–1.65 to 6.67), indicating substantial variability in intervention effects across studies.

In the present analysis, multiple outcome measures assessing the same underlying construct within individual studies were combined into study-level composite effect sizes for mental illness and positive mental health (psychological functioning), thereby ensuring statistical independence of observations and avoiding double counting of participants. The resulting pooled estimate therefore reflects the overall impact of SDT-based interventions across these two broad domains of mental health rather than across individual psychological outcomes.

(Insert Table 3)

3.4 Subgroup Analyses

To address the primary objectives of the review and consistent with Keyes' dual-continua conceptualization of mental health, subgroup analyses were conducted to examine whether the effects of SDT-based interventions differed across mental health outcome domains, SDT domains, and participant, methodological, and intervention characteristics. The results are presented below.

3.4.1 Outcome Domain (Mental Illness vs. Positive Mental Health [Psychological Functioning])

Separate random-effects meta-analyses were conducted for the two dimensions of mental health proposed by Keyes' dual-continua model, namely mental illness and positive mental health (psychological functioning).

SDT-based interventions demonstrated a large and statistically significant reduction in mental illness outcomes, with a pooled effect size of $g = 2.55$ (95% CI 1.55–3.53) (see Figure 3). This finding reflects substantial improvements in indicators such as depression, anxiety, stress, and psychological distress. However, significant between-study heterogeneity was observed (Q test, $p < .001$; $I^2 = 93\%$; prediction interval = -1.81 to 6.91).

Similarly, SDT-based interventions produced a large and statistically significant improvement in positive mental health (psychological functioning), with a pooled effect size of $g = 2.48$ (95% CI 1.49–3.46) (see Figure 2), reflecting improvements in psychological well-being, flourishing, life satisfaction, subjective vitality, and related constructs. Significant heterogeneity was also observed for this outcome domain (Q test, $p < .001$; $I^2 = 57\%$; prediction interval = -2.27 to 7.23).

Collectively, these findings indicate that SDT-based interventions are associated with substantial improvements in both mental illness outcomes and positive mental health (psychological functioning), supporting the potential of SDT-based approaches to promote holistic mental health across both dimensions of Keyes' dual-continua model.

(Insert Figure 2 and Figure 3 about here)

3.4.2 Participant Characteristics

Moderator analyses were conducted to examine whether participant characteristics influenced the effectiveness of SDT-based interventions. Significant intervention effects were observed among both adolescents ($g = 3.70$, 95% CI 2.22–5.18) and adults ($g = 2.21$, 95% CI 1.42–2.99). However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .179$), indicating that intervention effectiveness did not differ significantly between adolescent and adult populations (see Table 4).

Similarly, SDT-based interventions demonstrated significant effects in both non-WEIRD countries ($g = 3.43$, 95% CI 1.81–5.05) and WEIRD countries ($g = 2.31$, 95% CI 1.55–3.07). However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .220$), suggesting that intervention effectiveness was broadly comparable across cultural contexts (see Table 4).

Overall, these findings indicate that participant characteristics, including age group and cultural context, did not significantly moderate the effectiveness of SDT-based interventions in the present review.

3.4.3 Methodological Characteristics

Moderator analyses were conducted to examine whether study design influenced the effectiveness of SDT-based interventions. Significant intervention effects were observed in both randomized experimental studies ($g = 2.97$, 95% CI 2.01–3.92) and quasi-experimental studies ($g = 2.01$, 95% CI 1.01–3.01). However, the between-group comparison was not

statistically significant ($Q_{\text{between}}, p = .178$), indicating that intervention effectiveness did not differ significantly according to study design (see Table 4).

Overall, these findings suggest that SDT-based interventions demonstrated beneficial effects across both randomized experimental and quasi-experimental studies, with no evidence that methodological design significantly moderated the observed intervention effects.

3.4.4 Intervention Characteristics

Moderator analyses were conducted to examine whether intervention intensity, format, and mode of delivery influenced the effectiveness of SDT-based interventions. Significant intervention effects were observed across all levels of intervention intensity, including low-intensity ($g = 2.70$, 95% CI 1.49–3.91), moderate-intensity ($g = 2.24$, 95% CI 1.02–3.45), and high-intensity ($g = 2.64$, 95% CI 1.29–4.02) interventions. However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .850$), indicating that intervention intensity did not significantly moderate intervention effectiveness (see Table 4).

Similarly, significant effects were observed for both group-based interventions ($g = 2.52$, 95% CI 1.56–3.48) and individual interventions ($g = 2.56$, 95% CI 1.57–3.55). The between-group comparison was not statistically significant ($Q_{\text{between}}, p = .789$), suggesting comparable effectiveness across intervention formats. With respect to mode of delivery, both offline interventions ($g = 2.24$, 95% CI 1.41–3.07) and online interventions ($g = 3.27$, 95% CI 2.01–4.53) demonstrated significant intervention effects. However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .311$), indicating that intervention effectiveness did not differ significantly according to delivery mode (see Table 4).

Overall, these findings suggest that intervention intensity, format, and delivery mode did not significantly moderate the effectiveness of SDT-based interventions, with beneficial effects observed consistently across implementation characteristics.

3.4.5 SDT Domains (Autonomy, Competence, Relatedness, Motivation)

As the primary meta-analysis was based on study-level composite effect sizes representing mental illness and positive mental health, separate analyses of individual SDT domains could not be performed using the composite dataset. Therefore, to examine the relative contribution of the theoretical constructs underlying SDT, exploratory analyses were conducted using the original outcome-level dataset, in which individual outcomes were retained.

Among the three basic psychological needs, autonomy-supportive interventions demonstrated the largest pooled effect ($g = 1.12$, 95% CI 0.49–1.75). The between-group heterogeneity statistic was statistically significant ($Q_{\text{between}}, p < .001$), indicating variability in effect sizes across autonomy-, competence-, and relatedness-focused interventions (see Table 4). In a separate analysis, interventions targeting intrinsic motivation also demonstrated a statistically significant pooled effect ($g = 0.64$, 95% CI 0.04–1.23), although the heterogeneity statistic was not statistically significant ($Q_{\text{between}}, p = .232$).

Given that these analyses were conducted using the original outcome-level dataset rather than the composite study-level dataset employed in the primary meta-analysis, the findings should be interpreted as exploratory and theory-oriented, providing insight into potential SDT mechanisms rather than definitive evidence regarding the relative importance of individual SDT domains.

(Insert Table 4)

3.6 Risk of Bias Assessment

Risk of bias was evaluated using RoB 2 for randomized studies and ROBINS-I for quasi-experimental studies. Among the randomized studies, ten were judged to have low risk of bias, thirteen raised some concerns, and one was classified as high risk. Among quasi-experimental studies, nine demonstrated moderate risk of bias and ten demonstrated serious risk of bias (see Table 1; Figure 4).

(Insert Figure 4)

3.7 Sensitivity Analysis

As a supplementary robustness analysis, sensitivity analyses were conducted using the original outcome-level dataset by excluding studies with high or serious risk of bias. This analysis yielded a statistically significant pooled effect size ($g = 0.44$, 95% CI 0.12–0.75), while substantial heterogeneity remained (see Table 5). The persistence of a significant intervention effect following the exclusion of studies with elevated risk of bias provides additional support for the robustness of the findings. However, as this analysis was conducted using the original outcome-level dataset rather than the composite study-level dataset employed in the primary meta-analysis, the results should be interpreted as supplementary evidence and not as a direct sensitivity analysis of the primary pooled estimates.

(Insert Table 5)

3.8 Publication Bias

Egger's regression intercept test did not indicate significant publication bias ($p = .321$). Similarly, Duval and Tweedie's trim-and-fill procedure identified no missing studies, with observed and adjusted estimates remaining identical, suggesting minimal evidence of publication bias (see Tables 6–7; Figure 5).

(Insert Table 6 and Table 7) (Insert Figure 5)

4. Discussion

4.1 Summary of Principal Findings

The present systematic review and meta-analysis synthesized evidence from experimental and quasi-experimental studies to evaluate the effectiveness of SDT based interventions on mental health. Guided by Keyes' (2002) dual-continua model of mental health, the review extends previous meta-analytic evidence (Ng et al., 2012; Ryan et al., 2022) by simultaneously examining mental illness outcomes and positive mental health (psychological functioning) within a single evidence synthesis. A principal finding was that SDT-based interventions demonstrated large and statistically significant effects in both reducing mental illness outcomes and enhancing positive mental health (psychological functioning), suggesting that SDT-based interventions may promote holistic mental health through both the alleviation of psychological distress and the enhancement of adaptive psychological functioning (Franken et al., 2018; Westerhof & Keyes, 2010).

Using study-level composite effect sizes to account for multiple correlated outcomes within individual studies, the overall pooled effect of SDT-based interventions on mental health was large and statistically significant. Although substantial between-study heterogeneity remained, moderator analyses did not identify significant differences according to participant characteristics, study design, or intervention characteristics, suggesting that the beneficial effects of SDT-based interventions were broadly consistent across the populations and implementation contexts examined. Exploratory analyses based on the original outcome-level dataset indicated comparatively larger effect sizes for autonomy-supportive interventions, while autonomy-, competence-, and relatedness-supportive techniques were commonly represented across successful interventions. However, these findings should be interpreted cautiously given their exploratory nature and the substantial heterogeneity observed across studies (Gillison et al., 2019; Ntoumanis et al., 2021; Sheeran et al., 2020).

Collectively, the findings support SDT as a theoretically grounded framework for promoting holistic mental health by simultaneously reducing psychopathology and fostering positive psychological functioning, consistent with the dual-continua conceptualization of mental health (Keyes, 2002; Ryan & Deci, 2020; Westerhof & Keyes, 2010).

4.2 Mental Illness and Positive Mental Health (Psychological Functioning): A Dual-Continua Perspective

A major contribution of the present review is the separate quantitative synthesis of mental illness outcomes and positive mental health (psychological functioning) outcomes within Keyes' (2002) dual-continua framework of mental health. Unlike traditional conceptualizations that define mental health merely as the absence of psychopathology, the dual-continua model proposes that mental illness and positive mental health represent related but distinct dimensions, such that reductions in psychological symptoms do not necessarily imply the presence of flourishing or optimal psychological functioning (Keyes, 2002; Keyes, 2005; Westerhof & Keyes, 2010). Consistent with this theoretical perspective, the present review demonstrated that SDT-based interventions were associated with large and statistically significant improvements in both mental illness outcomes and positive mental health (psychological functioning), suggesting that these interventions may simultaneously

facilitate recovery from psychological distress while promoting adaptive psychological functioning (Franken et al., 2018; Iasiello et al., 2020).

These findings are consistent with SDT, which proposes that the satisfaction of the basic psychological needs for autonomy, competence, and relatedness fosters autonomous motivation, psychological integration, and optimal functioning (Deci & Ryan, 2000; Ryan & Deci, 2017, 2020). Need-supportive environments are theorized to buffer individuals against psychological distress while simultaneously promoting vitality, personal growth, psychological well-being, and flourishing (Ryan et al., 2022; Vansteenkiste et al., 2020). The present findings therefore provide empirical support for the proposition that SDT-based interventions may influence mental health through both illness reduction and the promotion of positive psychological functioning, rather than exclusively targeting symptom alleviation (Ntoumanis et al., 2021; Ryan et al., 2022).

The present review also extends previous SDT meta-analyses, which have primarily focused on health behaviours, motivation, or well-being in isolation (Ng et al., 2012; Ryan et al., 2022). By integrating mental illness outcomes and positive mental health (psychological functioning) outcomes within a single evidence synthesis using study-level composite effect sizes, the present review provides a broader evaluation of the potential mental health benefits of SDT-based interventions while avoiding dependence among multiple outcomes reported within individual studies. This approach offers a theoretically coherent framework for understanding how SDT-informed interventions may contribute to holistic mental health, encompassing both the reduction of psychopathology and the enhancement of positive psychological functioning (Franken et al., 2018; Iasiello et al., 2020).

The findings further resonate with recovery-oriented models of mental health, which emphasize that recovery extends beyond symptom remission to include the development of meaningful, satisfying, and socially connected lives despite the presence or history of mental illness (Slade, 2010; Slade et al., 2014, 2015). Collectively, the present findings provide quantitative support for the application of Keyes' dual-continua model as a useful conceptual framework for evaluating mental health interventions and suggest that SDT-based interventions may offer a promising approach for simultaneously reducing psychological distress and promoting flourishing across clinical and non-clinical populations (Iasiello et al., 2020; Westerhof & Keyes, 2010).

4.3 SDT Domains: Autonomy, Competence, Relatedness, and Motivation

Subgroup analyses indicated that interventions emphasizing autonomy demonstrated comparatively larger effect sizes on mental health outcomes, although all SDT domains contributed positively to intervention effectiveness. This finding is consistent with Self-Determination Theory, which identifies autonomy as a central psychological need underlying autonomous motivation and sustained behavioural change (Deci & Ryan, 2000; Ryan & Deci, 2017). Autonomy-supportive environments may enhance self-endorsed behaviour, engagement, and adaptive emotion regulation, thereby contributing to improvements in both mental illness outcomes and positive mental health (Ryan & Deci, 2020; Teixeira et al.,

2020). The significant effects observed for motivation further reinforce previous evidence linking autonomous motivation with psychological well-being and adaptive functioning (Howard et al., 2021; Ryan et al., 2022).

Importantly, autonomy support within SDT should not be interpreted as the absence of guidance or external structure. Rather, autonomy-supportive approaches can appropriately incorporate scaffolding, competence-enhancing feedback, co-regulation, and graduated decision-making support, particularly for individuals experiencing severe psychological distress or impaired executive functioning (Ryan & Deci, 2017; Teixeira et al., 2020). Thus, autonomy support is best conceptualized as facilitating volitional functioning within a structured and supportive interpersonal context, rather than promoting unrestricted independence (Soenens et al., 2007; Vansteenkiste et al., 2012). Consistent with SDT, autonomy, competence, and relatedness should therefore be viewed as complementary psychological needs, suggesting that interventions integrating support for all three needs are likely to provide the greatest potential for promoting holistic mental health (Deci & Ryan, 2000; Vansteenkiste et al., 2020).

4.4 Need-Supportive Intervention Techniques

The narrative synthesis demonstrated that successful SDT-based interventions consistently incorporated autonomy-, competence-, and relatedness-supportive techniques, although their implementation varied across settings and populations. Frequently identified strategies included providing meaningful rationales, offering behavioural choice, encouraging self-initiation, facilitating optimal challenge, providing constructive feedback, and fostering empathic and supportive interpersonal relationships. These techniques closely reflect the need-supportive strategies proposed within SDT (Deci & Ryan, 2000; Teixeira et al., 2020) and are theorized to facilitate the internalization of autonomous motivation. Rather than relying on isolated techniques, most interventions combined multiple need-supportive components, suggesting that their synergistic application may underlie improvements in both mental illness outcomes and positive psychological functioning (Gillison et al., 2019; Ntoumanis et al., 2021). The present synthesis therefore provides practical guidance for designing SDT-informed interventions that translate motivational theory into evidence-based mental health practice.

4.5 Moderator Findings

The present review did not identify statistically significant moderator effects for participant characteristics, methodological characteristics, or intervention characteristics. Significant intervention effects were observed across all examined subgroups, suggesting that the benefits of SDT-based interventions were broadly consistent across diverse populations and implementation contexts. This finding is consistent with SDT, which proposes that the basic psychological needs for autonomy, competence, and relatedness represent universal psychological processes that facilitate optimal functioning across developmental stages and cultures (Deci & Ryan, 2000; Ryan & Deci, 2017; Vansteenkiste et al., 2020).

Although numerical differences in effect sizes were observed across subgroups, the absence of statistically significant between-group differences suggests that these variations should be interpreted cautiously and are likely attributable to sampling variability or residual heterogeneity rather than systematic differences in intervention effectiveness (Cuijpers et al., 2021; Higgins et al., 2022). Importantly, a non-significant subgroup test does not establish that subgroup effects are identical; subgroup analyses may have limited statistical power, particularly when the number of studies is small or the subgroups are unevenly represented (Cuijpers et al., 2021). Similar observations have been reported in previous SDT meta-analyses (Ng et al., 2012; Ryan et al., 2022). Future studies employing standardized intervention protocols and larger evidence bases are needed to identify additional moderators that may explain the remaining heterogeneity and optimize SDT-based interventions across clinical and non-clinical populations.

4.6 Theoretical Implications

The present findings extend the SDT literature by integrating Keyes' (2002) dual-continua model of mental health with Self-Determination Theory. Whereas previous SDT meta-analyses have largely focused on health behaviours, motivation, or well-being in isolation (Ng et al., 2012; Ntoumanis et al., 2021; Ryan et al., 2022), the present review demonstrates that SDT-based interventions are associated with both reductions in mental illness outcomes and improvements in positive mental health (psychological functioning). These findings are consistent with SDT, which proposes that satisfaction of the basic psychological needs for autonomy, competence, and relatedness facilitates not only the prevention of psychological distress but also psychological growth and flourishing (Deci & Ryan, 2000; Ryan & Deci, 2017, 2020). By synthesizing both dimensions of mental health within a single evidence synthesis, the present review supports SDT as a comprehensive theoretical framework for understanding and promoting holistic mental health (Iasiello et al., 2020; Westerhof & Keyes, 2010).

4.7 Clinical and Practical Implications

The present findings have important implications for the development of motivation-based mental health interventions. Consistent with Keyes' (2002) dual-continua model, SDT-based interventions may contribute to both the reduction of psychological distress and the enhancement of positive mental health (psychological functioning), thereby extending intervention goals beyond symptom reduction alone (Franken et al., 2018; Slade, 2010). Incorporating autonomy-supportive communication, competence-enhancing feedback, and opportunities for meaningful interpersonal connection may complement existing evidence-based psychological interventions by promoting both recovery and psychological flourishing (Ryan & Deci, 2017; Teixeira et al., 2020). Given the broad applicability of SDT principles across healthcare, educational, organizational, and community settings, SDT-informed interventions may provide a useful framework for developing scalable mental health promotion programs that integrate symptom management with the promotion of positive psychological functioning and well-being (Gillison et al., 2019; Ntoumanis et al., 2021; Ryan et al., 2022).

4.8 Strengths and Limitations

The present review has several notable strengths. It was conducted in accordance with the Cochrane Handbook and PRISMA 2020 guidelines and was prospectively registered in PROSPERO, enhancing methodological transparency and reducing reporting bias. A comprehensive literature search, predefined eligibility criteria, standardized data extraction procedures, and systematic assessment of study quality using RoB 2 and ROBINS-I strengthened the methodological rigor of the review. Publication bias and sensitivity analyses were undertaken to examine the robustness of the findings. A further strength was the computation of study-level composite effect sizes for mental illness and positive mental health outcomes, which minimized dependence among multiple outcomes reported within individual studies while preserving the conceptual distinction proposed by Keyes' dual-continua model. The integration of quantitative meta-analysis with narrative synthesis also enabled the identification of commonly employed SDT-based intervention techniques and their potential theoretical relevance.

Nevertheless, several limitations should be acknowledged. Substantial between-study heterogeneity remained across analyses, suggesting that the pooled estimates should be interpreted as average effects across diverse populations, interventions, and outcome measures rather than precise estimates of intervention efficacy. Considerable variability in intervention content, implementation characteristics, and outcome measures may have contributed to this heterogeneity. Furthermore, the SDT-domain analyses (autonomy, competence, relatedness, and motivation) were conducted using the original outcome-level dataset and should therefore be interpreted as exploratory rather than definitive. Finally, because most interventions simultaneously incorporated multiple autonomy-, competence-, and relatedness-supportive techniques, the present review was unable to isolate the independent contribution of individual intervention components, and restricting the review to English-language publications may have introduced language bias.

4.9 Future Directions

Future research should prioritize methodologically rigorous randomized controlled trials employing standardized SDT-based intervention protocols and longer follow-up periods to evaluate the durability of intervention effects. Studies should simultaneously assess mental illness outcomes and positive mental health (psychological functioning) to better reflect the dual-continua conceptualization of mental health, while reporting participant characteristics such as baseline symptom severity, motivational readiness, and psychological need satisfaction more consistently to facilitate moderator analyses. Future investigations should also seek to identify the active intervention ingredients underlying SDT-based interventions through dismantling studies, factorial designs, or component network meta-analyses, thereby clarifying the relative contribution of autonomy-, competence-, and relatedness-supportive techniques across diverse populations and cultural contexts.

4.10 Conclusion

The present systematic review and meta-analysis suggests that SDT based interventions may promote holistic mental health by simultaneously reducing mental illness outcomes and enhancing positive mental health (psychological functioning). By synthesizing evidence within Keyes' dual-continua model of mental health, the review extends previous SDT evidence syntheses that have largely examined symptom reduction or well-being in isolation and provides a more comprehensive understanding of the potential mental health benefits of SDT-based interventions. Despite substantial between-study heterogeneity, the findings indicate that SDT-based interventions may offer a promising motivation-based framework for promoting both recovery from psychological distress and the enhancement of positive psychological functioning across diverse populations and settings. Future methodologically rigorous trials employing standardized intervention protocols and longer follow-up assessments are needed to clarify the mechanisms underlying these effects and to optimize the implementation of SDT-based interventions in clinical and non-clinical contexts.

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APPENDICES

Table 1: Summary of included studies

Sl No.	Author(s)	Year	Study Design	Sample	Country	SDT domains	Outcomes	Risk of Bias
1.	Latre-Navarro, Quintas-Hijos, & Sáez-Bondía	2024	Quasi-experimental	Adult	Spain	BPN Autonomy; Competence; Relatedness	Increased BPN in the intervention group; Time x interaction effects found for autonomy and competence; Favours intervention	Moderate
2	McMahon & Hanrahan	2020	Experimental	Adolescent	Australia	BPN	Reduced social anxiety; Increased relatedness; Favours intervention	Some concerns
3	Walters et al.	2023	Quasi-experimental	Adolescent	USA	BPN	Increased body esteem; Favours intervention	Moderate
4	Zhu et al.	2025	Quasi-experimental	Adult	Netherlands	Autonomy Competence Relatedness Autonomous motivation	Greater enjoyment and increased value of the curriculum; Favours intervention	Moderate
5	Schaper et al.	2022	Experimental	Adult	Germany	Autonomy Competence Relatedness Intrinsic motivation Identified motivation Extrinsic motivation	Increased autonomy; No effect on e-learning; Favours control group	Low
6	Behzadnia & FatahModares	2023	Experimental	Adult	Iraq	BPN	Increases need satisfaction, mindfulness and vitality; Reduced need- frustration, illness-anxiety and test anxiety; Favours intervention	Some concerns
7	Kiltz, Fokkens-Bruinsma & Jansen	2024	Quasi-experimental	Adult	Netherlands	Need Satisfaction and need frustration of Autonomy, competence, and relatedness	Competence linked with well-being and resilience; No significant effect of the intervention	Serious

8	Jang & Reeve	2021	Experimental	Both	Philippines	Intrinsic goal Autonomy Need satisfaction	Intrinsic goals linked with autonomy support and increased need satisfaction and teaching efficacy; Favours intervention	Some concerns
9	Van Hoecke et al.	2014	Experimental	Adult	Belgium	BPN	Increased physical well-being, non-significant increase in psychological well-being; Favours intervention	Moderate
10	Vanroy et al.	2017	Quasi-experimental	Adult	Belgium	BPN	No significant effect of the intervention	Serious
11	Conesa et al.	2023	Quasi-experimental	Adolescent	Spain	Autonomy Competence Relatedness Autonomous motivation	Increased students' autonomy, competence, autonomous motivation, and engagement. Favours intervention	Moderate
12	Tock et al.	2024	Experimental	Adult	Canada	BPN Autonomy Competence Relatedness	Increased psychological need satisfaction, quality of life and exercise motivation Favours intervention	Low
13	Triebner et al.	2024	Experimental	Adult	Germany	Autonomous motivation Controlled motivation Intrinsic motivation	Increased intrinsic motivation, autonomy. Reduced stress; Motivation mediated stress reduction; Favours intervention	Low
14	Nelson et al.	2015	Experimental	Adult	USA and South Korea	Autonomy	Increased well-being Increased well-being mediated by BPN Favours intervention	Low
15	Cheon et al.	2014	Experimental	Adolescent	South Korea	Autonomy support BPN	Increased motivation and well-being Favours intervention	Low
16	Lamoneda Prieto et al.	2024	Quasi-experimental	Adult	Spain	Autonomy Competence Relatedness	Improved autonomy Favours intervention	Serious
17	Emond Pelletier & Joussemet	2017	Experimental	Adult	Canada	Autonomy Competence Relatedness	Increased autonomy, value, and engagement. Reduced anxiety Favours intervention	Low
18	Farah & Nicole	2016	Experimental	Adult	Jordan	Need frustration	Reduced depressive symptoms and stress Favours intervention	Some concerns

19	Hooker et al.	2024	Quasi-experimental	Adult	USA	Autonomy Competence Relatedness Intrinsic motivation Identified motivation Integrated motivation	Increased autonomy, competence and meaning salience Favors intervention	Serious
20	Oram, Dou, & Rogers	2022	Experimental	Adult	Canada	BPN Autonomy Competence Relatedness Autonomous motivation	Increased BPN satisfaction Favors intervention	High
21	Wang, Hu, & Guo Study 1	2013	Experimental	Adolescent	China	Autonomy	Intrinsic goal setting was linked with better test performance and reduced test anxiety Favors intervention	Low
22	Wang, Hu, & Guo Study 2	2013	Experimental	Adolescent	China	Autonomy	Intrinsic goal setting had better test performance and reduced anxiety Favors intervention	Low
23	Ruf et al.	2024	Experimental	Adult	Austria	BPN	No significant effect on the psychological variables Did not favour intervention	Some concerns
24	Chemtob et al.	2019	Experimental	Adult	Canada	BPN Autonomous motivation	Increased autonomous motivation Favours the intervention	Some concerns
25	Pang & Woerkom	2025	Quasi-experimental	Adult	Switzerland	BPN	Reduced negative affect and perceived stress Favours intervention	Some concerns
26	Keeler et al. Study 1	2021	Quasi-experimental	Adult	USA	Autonomy Competence Relatedness	Reduced depression Favours intervention	Serious
27	Keeler et al. Study 2	2021	Quasi-experimental	Adult	USA	BPN	Reduced depression and distress Favours intervention	Serious
28	Fakieh Alrabai & Wala Algazzaz	2024	Quasi-experimental	Adult	Saudi Arabia	BPN	Increased BPN satisfaction and emotional engagement Favours intervention	Low

29	Behzadnia & FatahModares	2020	Experimental	Adult	Iran	Need satisfaction Need frustration Autonomous motivation	Increased need satisfaction, autonomous motivation, vitality Reduced need frustration, amotivation and perceived Favors intervention	Some concerns
30	Ha, Lonsdale, Lubans, & Ng	2020	Experimental	Adolescent	Hong Kong	Autonomy Competence Relatedness Autonomous motivation	Increased physical activity Stronger interventional effects for females with respect to autonomy, competence, and motivation Favours intervention	Low
31	Vella-Brodrick, Chin, & Rickard	2020	Quasi-experimental	Adolescent	Australia	Autonomy Competence Relatedness	Increased autonomy, competence, relatedness Favours intervention	Serious
32	Weigensberg et al.	2018	Quasi-experimental	Adult	USA	BPN	Reduced perceived stress and depression Increased well-being Favours intervention	Serious
33	Manzano-Sánchez et al.	2019	Quasi-experimental	Adolescent	Spain	Intrinsic motivation Extrinsic motivation Autonomy Competence Relatedness	Increased personal responsibility Increased BPN and intrinsic motivation in females Favours intervention	Moderate
34	Hooker, Masters, & Ranby	2020	Experimental	Adult	USA	BPN	No significant effect on SDT constructs Did not favour the intervention	Some concerns
35	Park et al.	2020	Quasi-experimental	Adult	New Zealand	BPN	Increased well-being Reduced problematic gaming Favours the intervention	Serious
36	Shannon et al.	2019	Quasi-experimental	Adult	Ireland	Competence	Increased competence, mindful awareness and well-being Reduced stress Favours intervention	Low
37	Gradito Dubord et al.	2022	Quasi-experimental	Adult	Canada and France	Need satisfaction Need frustration Autonomous motivation Controlled motivation	Increased strength use, need satisfaction, autonomous motivation and psychological well-being	Serious

							Increased need satisfaction led to increased motivation, which resulted in increased well-being	
38	Sagaribay	2024	Experimental	Adult	USA	Autonomy Competence Relatedness	Favours the intervention No changes in BPN Improved depression, anxiety, stress and body image satisfaction	Some concerns
39	Robinson	2024	Experimental	Adult	USA	Autonomy Competence Relatedness	Favours the intervention Negative correlation between PTSD and SDT constructs	Some concerns
40	Ataşalar	2017	Quasi-experimental	Adolescent	Turkey	BPN	Did not favour the intervention Increased need satisfaction, but overall, no effects on other variables	Moderate
41	Alvarez	2015	Quasi-experimental	Adult	USA	Autonomy Competence Relatedness External Introjected Identified Intrinsic	Did not favour the intervention Increased intrinsic regulation Did not favour the intervention	Serious
42	Chiu	2022	Experimental	Adult	Hong Kong	Perceived autonomy Perceived competence Perceived relatedness	Increased need satisfaction led to high-quality teaching practices integrated with technology	Some concerns
43	White, Lubans, & Eather	2022	Experimental	Adolescent	Australia	BPN	High levels of satisfaction and adherence. Medium positive effects on mental health and social health. Favours the intervention	Some concerns

Table 2: Techniques used to address BPN

SDT Domain	Specific Techniques	Operationalized as	No. of studies using them	% of studies	References
Autonomy	A1. Elicit perspectives on condition or behaviour	Discussing about own opinions regarding the behaviour to be changed	9	20.93%	S14, S15, S19, S20, S23, S35, S36, S37, S43
	A2. Prompt identification of sources of pressure for behaviour change	Identifying various behaviours and reasons to change current behaviour to target behaviour	16	37.21%	S3, S12, S13, S15, S16, S18, S21, S22, S23, S26, S27, S31, S35, S38, S41, S42
	A3. Use non-controlling, informational language	Making the language more informative and suggestive by using words like 'may', 'can', etc	16	37.21%	S6, S8, S9, S10, S11, S15, S16, S17, S20, S21, S22, S28, S30, S33, S36, S40
	A4. Explore life aspirations and values	Enquire about current values regarding target behaviour and life goals.	9	20.93%	S4, S8, S12, S18, S20, S21, S22, S24, S39
	A5. Provide a meaningful rationale	Explain the need for change and the need to attend the intervention	20	46.51%	S1, S6, S7, S9, S11, S13, S14, S15, S17, S18, S19, S21, S22, S23, S24, S30, S31, S34, S39, S40
	A6. Provide choice	Giving a few exercises and asking to choose one. Choice to perform any one task from a list of tasks on a given day.	24	55.81%	S1, S3, S4, S5, S6, S8, S9, S11, S12, S13, S14, S15, S16, S17, S19, S21, S22, S23, S24, S26, S27, S29, S40, S41, S42, S43
	A7. Encourage the person to experiment and self-initiate the behaviour	Individually engaging in a task, self-paced and self-timed homework	21	48.84%	S3, S4, S6, S7, S8, S10, S11, S13, S16, S21, S22, S29, S31, S32, S34, S35, S37, S38, S39, S42
Competence	C1. Address obstacles to change	After engaging in a behaviour, explore barriers to achieving the target behaviour with the help of experts.	15	34.88%	S2, S4, S9, S12, S18, S19, S20, S26, S27, S31, S33, S36, S38, S41, S43
	C2. Clarify expectations	Before engaging in a target behaviour, set realistic goals and timelines to achieve them	14	32.56%	S4, S6, S7, S9, S16, S20, S23, S25, S28, S33, S38, S40, S42, S43
	C3. Assist in setting optimal challenge	The expert gradually increases the difficulty of tasks to achieve the target behaviour based on the performance	26	60.47%	S2, S3, S6, S7, S8, S9, S10, S12, S13, S15, S16, S17, S18, S19, S20, S24, S25, S26, S27, S30, S31, S33, S39, S41, S42, S43

	C4. Offer constructive, clear, and relevant feedback	Discuss and offer feedback on how to improve and maintain the performance	18	41.86%	S1, S4, S5, S7, S9, S11, S12, S13, S16, S20, S24, S26, S27, S30, S35, S36, S40, S41
	C5. Help develop a clear and concrete plan of action	The overall list of tasks expected to be completed to attain the target behaviour is shared	17	39.53%	S1, S3, S9, S10, S12, S15, S18, S23, S25, S31, S34, S35, S36, S38, S39, S40, S42
	C6. Promote self-monitoring	Enable the participant to self-monitor the progress by pre-specifying the deadlines	12	27.91%	S1, S6, S11, S13, S19, S24, S29, S30, S32, S34, S35, S38
	C7. Explore ways of dealing with pressure	Teach how to effectively manage time	5	11.63%	S2, S32, S33, S36, S43
Relatedness	R1. Acknowledge and respect perspectives and feelings	Engage in conversations with peers and partners engaging in the same task	17	39.53%	S1, S2, S6, S8, S9, S13, S15, S18, S20, S23, S24, S33, S36, S37, S39, S40, S43
	R2. Encourage asking of questions	Questions to reflect on the current progress	14	32.56%	S4, S7, S9, S13, S9, S13, S15, S23, S26, S27, S28, S30, S31, S35
	R3. Show unconditional regard	Give positive feedback on efforts taken	5	11.63%	S9, S14, S18, S37, S43
	R4. Demonstrate/show interest in the person	Individually ask for lived experiences related to the target behaviour	18	41.86%	S2, S5, S6, S8, S9, S10, S13, S14, S15, S16, S18, S32, S35, S37, S38, S39, S40, S43
	R5. Use empathic listening	Communicate empathetically verbally and non-verbally	13	30.23%	S2, S5, S9, S15, S17, S20, S24, S28, S30, S32, S33, S37, S40
	R6. Providing opportunities for ongoing support	Peer support in groups	18	41.86%	S1, S3, S10, S12, S13, S14, S16, S22, S25, S26, S27, S29, S31, S32, S35, S38, S41, S42
	R7. Prompt identification and seek available social support	Peer support, referral system and appointment with experts	13	30.23%	S2, S3, S24, S26, S27, S29, S31, S32, S34, S38, S41, S42, S43

*A1-A7, C1-C7, R1-R7 refer to unique serial numbers given to each technique

*S1-S43 refers to Study 1- Study 43 corresponding to serial numbers in Table 1

Table 3: Meta-analysis of the overall effectiveness of SDT-based interventions in the mental health domain

Mean effect size	Std error	Variance	Confidence interval	Z value	p value	Prediction interval	Q value	p value	I square
								(Q)	
2.511	0.345	0.119	1.83 3.18	7.28	0.001	-1.64 6.67	460.047	0.001	86%

Table 4: Subgroup Analyses

Variables	Mean effect size	Std error	Variance	Confidence interval	Z value	p value	Prediction interval	Q value TOTAL BETWEEN	p-value (Q)
BPN									
Autonomy	1.12	0.32	0.10	0.49 1.75	3.49	0.001	-2.42 4.67	27.71	0.001
Motivation	0.64	0.30	0.09	0.04 1.23	2.11	0.035	-2.89 4.17	1.43	0.232
Mental health indicators									
Mental Illness	2.54	0.50	0.25	1.55 3.53	5.05	0.001	-1.81 6.91	372.93	0.001
Positive Mental Health	2.48	0.47	0.22	1.49 3.46	4.94	0.001	-2.27 7.23	86.74	0.001

Age

Adolescent	3.71	0.75	0.56	2.22	4.91	0.001	-0.8	3.44	0.179
				5.18					
Adult	2.21	0.40	0.16	1.42	5.50	0.001	-2.11		
				2.99					

Country

Non-WEIRD	3.43	0.82	0.68	1.81	4.14	0.001	-1.11	1.50	0.220
				5.05					
WEIRD	2.31	0.38	0.15	1.55	5.95	0.001	-1.99		
				3.07					

Study design

Experimental	2.97	0.48	0.23	2.01	6.07	0.001	-1.40	1.81	0.178
				3.92					
Quasi-experimental	2.01	0.51	0.26	1.01	3.95	0.001	-2.36		
				3.01					

Format of therapy

Group	2.52	0.48	0.23	1.56	5.15	0.001	-1.77	0.47	0.789
				3.48					
Individual	2.56	0.50	0.25	1.57	5.06	0.001	-1.74		
				3.55					

Intensity									
Low	2.70	0.61	0.38	1.49	4.36	0.001	-2.05		0.851
				3.91					
Moderate	2.24	0.62	0.38	1.02	3.61	0.001	-2.52	0.322	
				3.45					
High	2.64	0.69	0.47	-1.29	3.83	0.001	-2.15		
				4.00					
Delivery mode									
Offline	2.24	0.42	0.17	1.41	5.31	0.001	-2.02	2.33	0.311
				3.07					
Online	3.27	0.64	0.41	2.01	5.07	0.001	-1.11		
				4.53					

Table 5: Sensitivity analysis

Mean effect size (before)	Mean effect size (after)	Std error	Variance	Confidence interval	Z value	p value	Prediction interval	Q value	p value (Q)	I square
0.30	0.44	0.16	0.03	0.12	2.72	0.006	-3.53	20119.96	0.001	99.22
				0.75			4.40			

Table 6: Egger's Regression Intercept

Intercept	Standard Error	Upper Limit	Lower Limit	t-value	p-value (2-tailed)	p-value (1-tailed)
1.35	1.36	-1.33	4.04	0.99	0.32	0.16

Table 7: Duval and Tweedie's Trim and Fill (Random effects Model)

	Point Estimate	Lower Limit	Upper Limit	Q statistic
Observed	0.30	0.73	0.54	20423.42
Adjusted	0.30	0.73	0.54	20423.42

Figure 1: PRISMA flow diagram of study selection

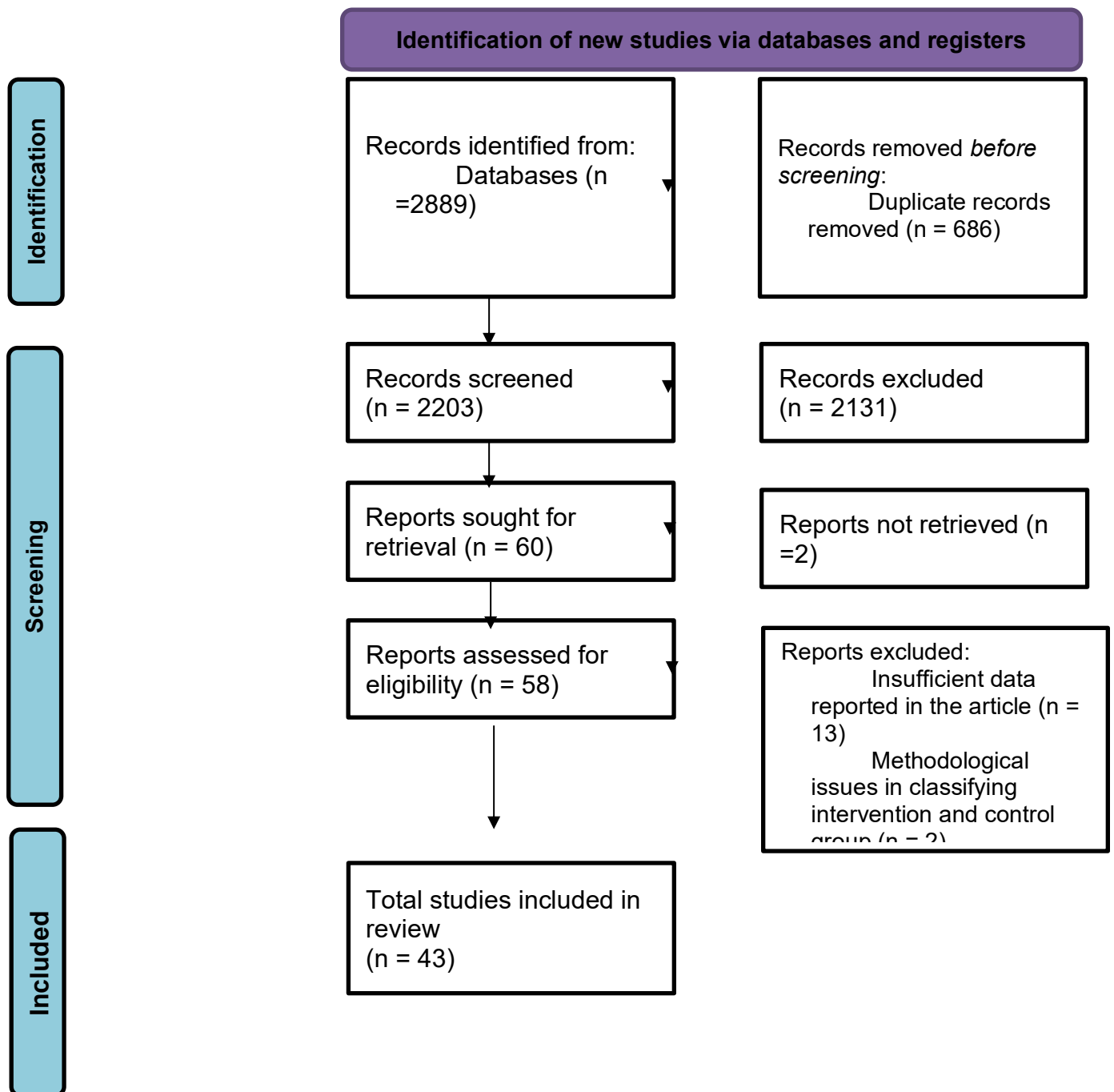


Figure 2: Forest plot of the pooled effect of SDT-based interventions on positive-mental health

Positive Mental Health forest plot

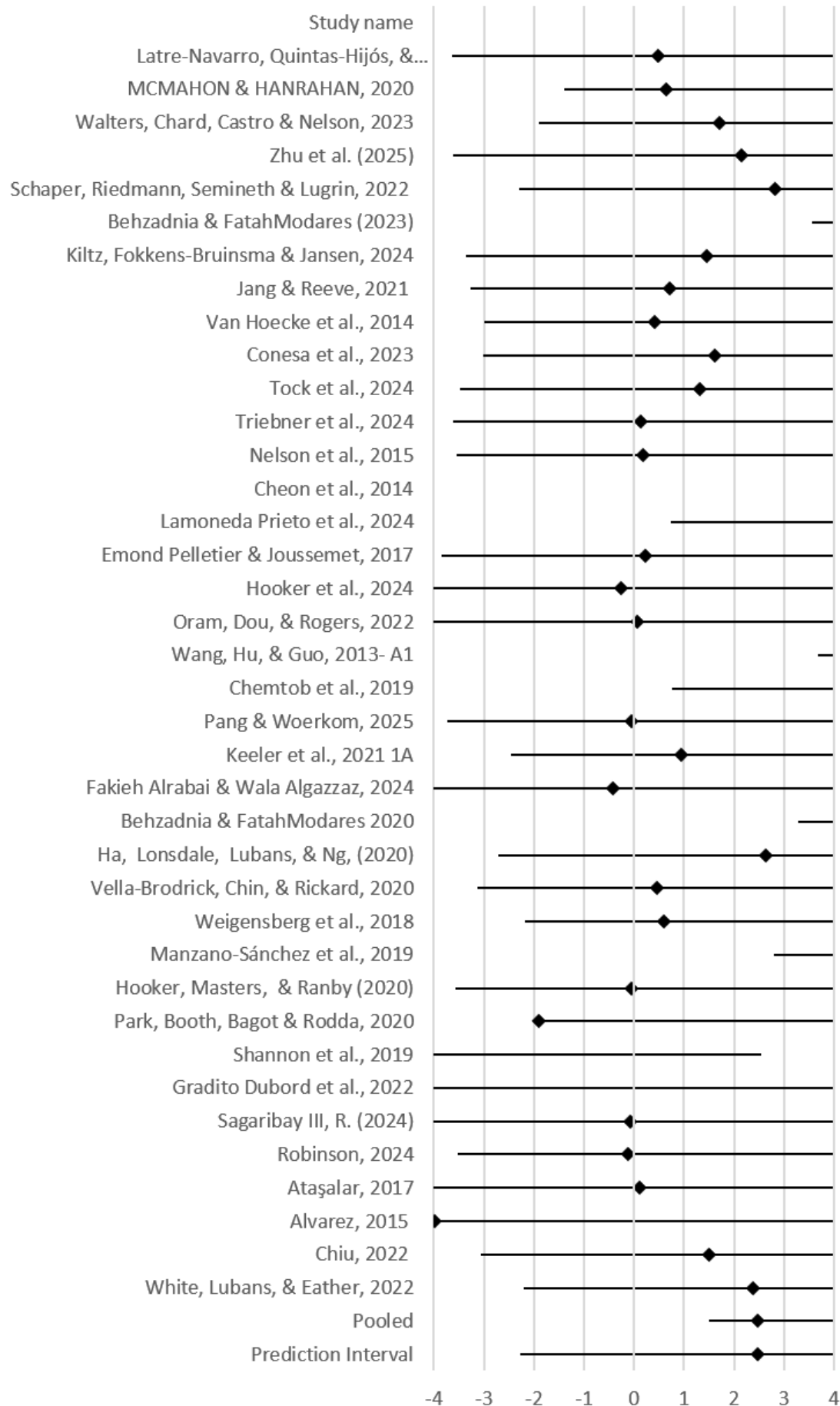


Figure 3: Forest plot of the pooled effect of SDT-based interventions on mental illness outcomes

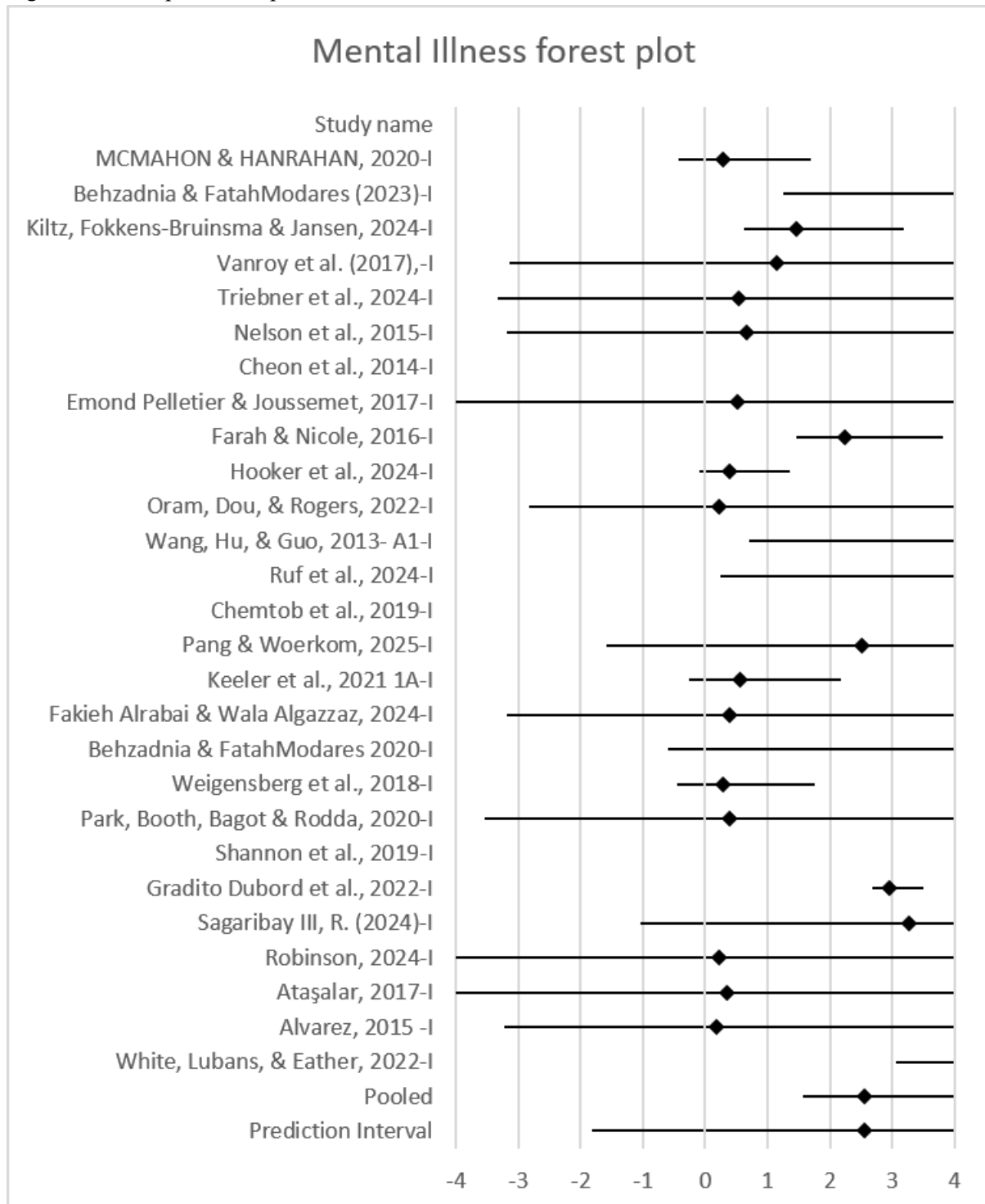


Figure 4: Risk of bias assessment of the included studies.

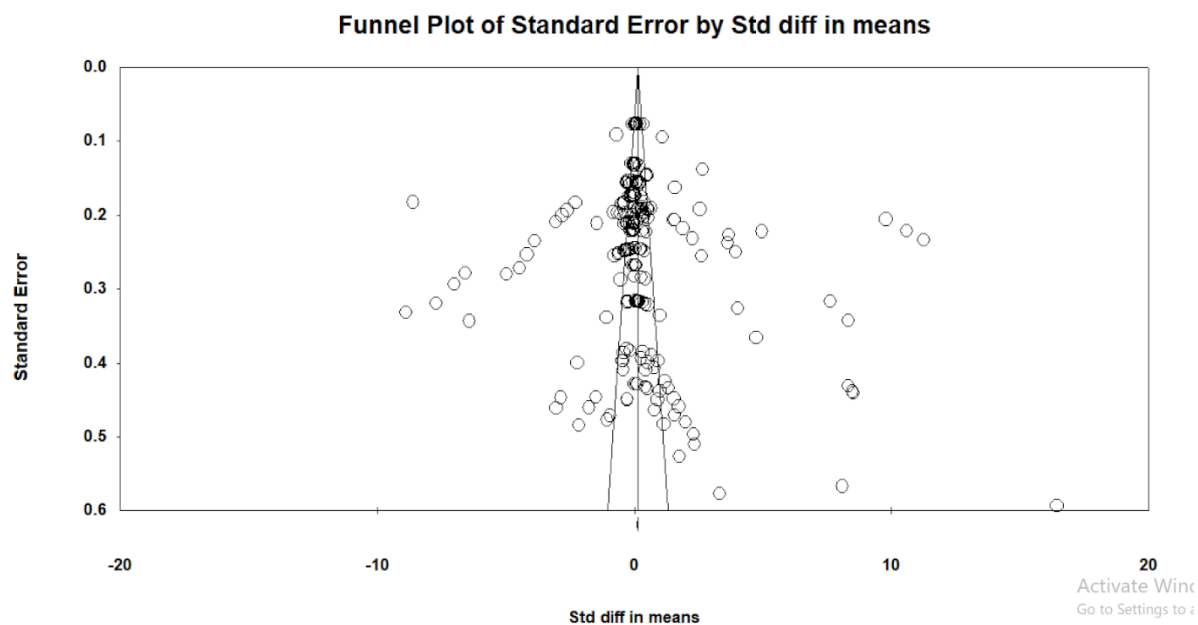
	Risk of bias domains				
	D1	D2	D3	D4	D5
Tock et al.,2024					
Triebner et al.,2024					
Nelson et al.,2015					
Cheon et al.,2014					
Emond Pelletier & Joussemet, 2017					
Farah & Nicole, 2016					
Oram, Dou, & Rogers, 2022					
Wang, Hu, & Guo, 2013					
Ruf et al., 2024)					
Chemtob et al., 2019					
Pang & Woerkom, 2025					
Behzadnia & FatahModares, 2020					
Sagaribay III, R. (2024)					
Robinson, 2024					
Chiu, 2022					
White, Lubans, & Eather, 2022					
McMahon & Stephanie J. Hanrahan (2020)					
9.Schaper, Riedmann, Semineth & Lugin, 2022					
Behzadnia & FatahModares (2023)					
53.Ha, Lonsdale, Lubans, & Ng, (2020)					
51.Hooker, Masters, & Ranby (2020))					

Study

Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
 High
 Some concerns
 Low

Figure 5: Funnel plot for assessment of publication bias.



SUPPLEMENTARY FILE

Table S2. Classification and Operationalization of Outcome Measures According to the Dual-Continua Framework of Mental Health

Outcome domain	Outcome construct	Operational definition in the present review	Representative psychometric measure(s)	Basis for classification
Mental illness outcomes	Depression	Severity of depressive symptoms, including affective, cognitive, and somatic manifestations of depression	Beck Depression Inventory (BDI); Center for Epidemiologic Studies Depression Scale (CES-D); Patient Health Questionnaire-9 (PHQ-9); Zung Self-Rating Depression Scale	Symptom-based indicator of psychopathology and psychological distress
Mental illness outcomes	Anxiety	Severity of general, state/trait, social, or context-specific anxiety symptoms	Beck Anxiety Inventory (BAI); State-Trait Anxiety Inventory (STAI); Social Interaction Anxiety Scale (SIAS); Social Physique Anxiety Scale (SPAS)	Symptom-based indicator of anxiety-related psychological distress
Mental illness outcomes	Stress	Perceived psychological stress or severity of stress-related symptoms	Perceived Stress Scale (PSS); Depression Anxiety Stress Scales—Stress subscale (DASS-Stress)	Indicator of psychological distress
Mental illness outcomes	Psychological distress	Non-specific psychological distress or	Kessler Psychological Distress Scale (K10/K6); Brief Symptom Inventory	Indicator of non-specific psychological distress or symptom burden

		broader emotional and psychological symptom burden	(BSI-18); Self-Reporting Questionnaire (SRQ-20)	
Mental illness outcomes	Trauma-related symptoms	Severity of post-traumatic stress and related trauma symptoms	PTSD Symptom Scale–Self-Report (PSS-SR)	Symptom-based indicator of trauma-related psychopathology
Mental illness outcomes	General psychopathology / emotional and behavioural difficulties	Broad psychological, emotional, or behavioural difficulties representing maladaptive functioning or symptom burden	Strengths and Difficulties Questionnaire (SDQ); DASS-21 Total Score	Classified within this domain when the extracted outcome represented psychological, emotional, or behavioural difficulties
Mental illness outcomes	Body-esteem-related dysfunction	Body-related self-evaluation as operationalized in the included study and analysed as an indicator of psychological dysfunction	Body-Esteem Scale for Adolescents and Adults	Retained within the domain in which the outcome was classified <i>a priori</i> for the quantitative synthesis
Positive mental health (psychological functioning)	Life satisfaction	Cognitive evaluation of satisfaction with one's life overall or relevant life domains	Satisfaction With Life Scale (SWLS); Life Satisfaction Scale for Adolescents; Life Satisfaction Questionnaire	Indicator of subjective well-being and positive psychological functioning

Positive mental health (psychological functioning)	Subjective well-being / happiness	Positive subjective appraisal of happiness and overall well-being	Subjective Happiness Scale; Warwick-Edinburgh Mental Well-being Scale (WEMWBS); WHO-5 Well-Being Index	Indicator of positive emotional and psychological well-being
Positive mental health (psychological functioning)	Psychological well-being	Positive psychological functioning encompassing dimensions such as purpose in life, personal growth, autonomy, environmental mastery, positive relations, and self-acceptance	Ryff Psychological Well-Being Scale	Core indicator of positive psychological functioning
Positive mental health (psychological functioning)	Flourishing	Positive psychosocial functioning and perceived thriving across important domains of life	Flourishing Scale	Indicator of positive mental health and adaptive psychological functioning
Positive mental health (psychological functioning)	Positive affect	Experience or frequency of positive emotional states	Positive-affect measure(s) reported in the included studies	Indicator of positive emotional well-being
Positive mental health	Subjective vitality	Subjective experience of energy, aliveness,	Subjective Vitality Scale	Positively oriented indicator of adaptive psychological functioning

(psychological functioning)		and psychological vitality		
Positive mental health (psychological functioning)	Hope	Positive goal-directed functioning involving perceived capacity to pursue and identify pathways toward desired goals	Hope Scale	Positively oriented indicator of adaptive psychological functioning
Positive mental health (psychological functioning)	Meaning in life	Perceived presence of meaning, purpose, or coherence in one's life	Meaning in Life Questionnaire (MLQ)	Positively oriented indicator of adaptive psychological functioning
Positive mental health (psychological functioning)	Self-efficacy	Perceived capability to manage demands or successfully perform relevant behaviours	Self-efficacy measure(s) reported in the included studies	Broader indicator of adaptive psychological functioning rather than a core component of Keyes' positive mental health model
Positive mental health (psychological functioning)	Social well-being / functioning	Positive functioning in interpersonal relationships, social roles, or broader social contexts	Social well-being/functioning measure(s) reported in the included studies	Indicator of social and adaptive functioning

Positive mental health (psychological functioning)	Quality of life	Perceived well-being and functioning across relevant life domains	Quality-of-life measure(s) reported in the included studies	Included within the broader positive psychological functioning domain when the extracted outcome represented well-being or adaptive functioning
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Note. Outcome classification was organized within Keyes' (2002) dual-continua framework, in which mental illness and positive mental health are conceptualized as related but distinct dimensions. Mental illness outcomes comprised symptom-based indicators of psychopathology, psychological distress, and related dysfunction. Positive mental health outcomes primarily comprised indicators of emotional, psychological, and social well-being; additional positively oriented constructs were included within the broader positive psychological functioning domain when they represented adaptive functioning rather than symptoms of psychopathology. The latter constructs should not necessarily be interpreted as core components of Keyes' model. Outcomes were classified according to the construct assessed, its interpretation in the included study, and the *a priori* classification used for the quantitative synthesis. Effect-size directions were harmonized so that positive values consistently represented improved mental health.

REVIEWERS' COMMENTS AND REVISIONS

Reviewer Comments	Responses
The manuscript would benefit from providing more citations to support several arguments. Several sentences, and in some cases entire paragraphs (particularly in the Introduction), lack supporting references, which may give the impression that they reflect the authors' opinions rather than evidence-based arguments. Strengthening these sections with appropriate citations would improve the scientific rigor of the manuscript and better establish the research gap and the significance of the study. Several arguments would benefit from additional supporting citations, particularly where claims are presented without empirical evidence. The discussion of Self-Determination Theory (SDT) would benefit from incorporating more recent references. While the seminal work from 2000 is appropriate, citing more recent developments of the theory would strengthen the theoretical foundation and demonstrate its continued relevance.	We thank the reviewer for this important observation. We carefully reviewed the Introduction and Discussion and added supporting citations to statements concerning mental health, the dual-continua model, positive psychological functioning, mental illness, SDT, need satisfaction, need-supportive interventions, and the identified research gaps. In addition to the seminal work of Deci and Ryan (2000), we incorporated more recent theoretical and meta-analytic literature, including Ryan and Deci (2020), Ryan et al. (2022), Ntoumanis et al. (2021), and related contemporary sources. These revisions strengthen the evidence base and clarify the rationale and significance of the present review.

The Introduction could be further improved by making the writing more concise and enhancing the overall logical flow.	We appreciate this suggestion. The Introduction was revised to reduce repetition, combine overlapping arguments, and improve transitions between the burden of mental disorders, the dual-continua model, SDT, previous meta-analytic evidence, research gaps, and the rationale for the present review. The revised structure now progresses more clearly from the broader conceptualization of mental health to the relevance of SDT and the specific contribution of the present systematic review and meta-analysis.
Although the revised manuscript acknowledges that mental health encompasses both psychological functioning and mental illness, the conceptualization of the outcome variables remains insufficiently clear. The manuscript would benefit from explicitly defining each outcome, providing its operationalization, and clarifying the theoretical framework on which it is based. While Keyes' dual-continua model provides a useful overarching framework, it does not comprehensively define the specific components or symptoms of each outcome domain. Therefore, it would be helpful to incorporate additional theoretical references to support the conceptualization of both positive psychological functioning and mental illness indicators, and to clearly explain how these constructs were operationalized in the present review.	We thank the reviewer for highlighting this conceptual issue. We revised the manuscript to define the two outcome domains explicitly. Mental illness outcomes are now described as symptom-based indicators of psychopathology and psychological distress, including depression, anxiety, stress, trauma-related symptoms, and general psychological distress. Positive mental health, referred to as positive psychological functioning, is defined as emotional, psychological, and social well-being, including flourishing, life satisfaction, positive affect, psychological well-being, subjective vitality, hope, meaning in life, self-efficacy, and quality of life. We also clarified that mental illness outcomes generally reflected symptom severity, whereas positive mental health outcomes reflected the presence of well-being and adaptive functioning. The revised conceptualization is supported by Keyes (2002, 2005), Westerhof and Keyes (2010), Ryff (1989), Ryff and Keyes (1995), and Diener et al. (2010).

METHOD Please clarify which specific conditions or indicators were categorized under each outcome domain (i.e., psychological functioning and mental illness), and provide appropriate supporting references for these classifications.	We have clarified the classification procedure in the Methods section. Mental illness outcomes included depression, anxiety, perceived stress, post-traumatic stress, general psychological distress, and related indicators of psychological dysfunction. Positive mental health or psychological functioning outcomes included flourishing, life satisfaction, happiness, positive affect, psychological well-being, social well-being, subjective vitality, hope, meaning in life, self-efficacy, and quality of life. The classification was conducted a priori using Keyes' dual-continua framework and was supported by relevant theoretical and measurement literature, including Keyes (2002, 2005), Westerhof and Keyes (2010), Diener et al. (2010), Ryff (1989), Ryff and Keyes (1995), Kessler et al. (2002), Kroenke et al. (2001), Beck et al. (1988), and Lovibond and Lovibond (1995). A complete classification of the instruments and constructs is now provided in Supplementary Table S1.
Please provide a citation supporting the selected age range used in the inclusion criteria.	We have added a citation supporting the developmental age range used in the inclusion criteria. Specifically, the revised manuscript now cites Sawyer et al. (2018), who identify adolescence as a distinct developmental period extending from approximately 10 to 19 years. This citation provides a developmental rationale for including adolescent and adult populations and clarifies the basis for the selected age criteria.
Please define the abbreviation WEIRD when it first appears in the manuscript.	We have defined the abbreviation at first use as Western, Educated, Industrialized, Rich, and Democratic. The manuscript now explains that the term refers to populations and cultural contexts that are overrepresented in psychological research and may not adequately represent global populations.

Figure 1 could be improved to enhance readability and visual clarity.	We thank the reviewer for this suggestion. Figure 1 was revised to improve visual clarity and readability. The revised figure uses a clearer layout, improved spacing, more legible font sizes, consistent labels, and better alignment of the relevant study-selection stages. Redundant visual elements were removed, and the figure was checked to ensure that all labels and numerical information are clearly visible.
Table 1 may be easier to read if presented in landscape orientation or reformatted for improved readability.	We have reformatted Table 1 and presented it in landscape orientation to accommodate the information more effectively. Column widths, font size, spacing, and alignment were adjusted to improve readability while retaining all relevant information. The table was also checked to ensure that it remains legible when viewed and printed in the final manuscript format.
The Discussion would benefit from additional citations to support several interpretations and arguments. This would reduce reliance on unsupported statements and strengthen the integration of the findings with the existing literature. Where appropriate, consider incorporating more recent references.	We appreciate this recommendation. Additional citations were incorporated throughout the Discussion to support interpretations concerning the dual-continua model, the simultaneous reduction of psychological distress and enhancement of positive psychological functioning, the role of autonomy, competence, relatedness, need-supportive techniques, the universality of basic psychological needs, recovery-oriented mental health, and the interpretation of moderator findings. Recent sources, including Ryan et al. (2022), Ntoumanis et al. (2021), Howard et al. (2021), Teixeira et al. (2020), and Cuijpers et al. (2021), were added where appropriate. These revisions improve the integration of the findings with contemporary theoretical and empirical literature.
Please include DOI information for references whenever available and consistent with the journal's formatting guidelines.	We have reviewed the complete reference list and added DOI information for references for which a DOI was available. The DOI format has

	been standardized according to the journal's formatting requirements. References for which no DOI could be identified, including books, manuals, and selected institutional publications, have been retained without a DOI or marked as unavailable where appropriate. The reference list was also checked for consistency in capitalization, journal titles, volume and issue information, page ranges, and DOI presentation.

Abstract

Background: Self-Determination Theory (SDT) proposes that satisfaction of the basic psychological needs for autonomy, competence, and relatedness promotes psychological growth and mental health. However, previous evidence syntheses have largely examined psychopathology or well-being separately. The present systematic review and meta-analysis evaluated the effects of SDT-based interventions on mental health while separately examining mental illness outcomes and positive mental health (psychological functioning) within Keyes' dual-continua framework.

Methods: A systematic review and meta-analysis of 43 experimental and quasi-experimental studies was conducted. Random-effects meta-analyses estimated pooled intervention effects using study-level composite effect sizes for mental illness and positive mental health outcomes, while narrative synthesis summarized need-supportive intervention techniques. Moderator analyses examined participant, methodological, and intervention characteristics.

Results: SDT-based interventions demonstrated a large overall effect on mental health ($g = 2.51$). Separate analyses based on Keyes' dual-continua model indicated large effects for both mental illness reduction ($g = 2.55$) and positive mental health (psychological functioning; $g = 2.48$). Moderator analyses did not identify statistically significant differences according to participant, methodological, or intervention characteristics. Substantial between-study heterogeneity remained, warranting cautious interpretation of the pooled estimates.

Conclusions: SDT-based interventions may promote holistic mental health by reducing mental illness outcomes while enhancing positive mental health (psychological functioning). Integrating these outcomes within Keyes' dual-continua model extends previous SDT evidence syntheses and highlights the potential of SDT as a theoretically grounded framework for promoting both recovery from psychological distress and positive psychological functioning.

Key words: Self-Determination Theory; Psychological Well-Being; Mental Health; Motivation; Psychological Interventions; Meta-Analysis

1.0 Introduction

Mental disorders are among the leading contributors to disability worldwide and impose substantial personal, social, and economic burdens (Vigo et al., 2016). Although psychological interventions have traditionally been evaluated primarily through symptom reduction, contemporary perspectives emphasize that mental health involves more than the absence of psychopathology. It also includes positive psychological functioning, well-being, and the capacity to flourish (Keyes, 2002; Westerhof & Keyes, 2010).

Keyes' (2002) dual-continua model provides an overarching framework for understanding mental health as comprising two related but distinct dimensions: mental illness and positive mental health. Mental illness was conceptualized in the present review as the severity of psychological symptoms, including depression, anxiety, stress, post-traumatic stress, and general psychological distress. These outcomes were assessed through symptom-based measures such as the Beck Depression Inventory, Beck Anxiety Inventory, Depression Anxiety Stress Scales, Patient Health Questionnaire, Center for Epidemiologic Studies Depression Scale, and Kessler Psychological Distress Scale (Beck et al., 1988; Kessler et al., 2002; Kroenke et al., 2001; Lovibond & Lovibond, 1995; Radloff, 1977). Thus, this domain reflected the intensity of psychological symptoms rather than solely the presence or absence of a formal psychiatric diagnosis.

Positive mental health, referred to in this review as positive psychological functioning, was conceptualized as the presence of adaptive emotional, psychological, and social functioning. It included indicators such as life satisfaction, flourishing, positive affect, psychological well-being, social well-being, subjective vitality, meaning in life, hope, and general mental well-being. This conceptualization is consistent with Keyes' (2002, 2005) model and broader theories of psychological well-being, which emphasize autonomy, personal growth, positive relationships, purpose in life, environmental mastery, and self-acceptance (Diener et al., 2010; Ryff, 1989; Ryff & Keyes, 1995). Therefore, positive mental health represented the presence of well-being and adaptive functioning rather than merely the absence of psychological symptoms.

Accordingly, the present review operationalized mental illness outcomes through continuous scores reflecting psychological symptoms, with higher scores generally indicating greater distress or psychopathology. Positive mental health outcomes were operationalized through continuous scores reflecting well-being, flourishing, life satisfaction, vitality, meaning, hope, and adaptive psychological functioning. Overall mental health was examined by synthesizing relevant effects across both domains while retaining separate estimates for mental illness and positive mental health outcomes.

Self-Determination Theory (SDT; Deci & Ryan, 2000) provides a complementary framework for explaining these outcomes. Satisfaction of autonomy, competence, and relatedness is

theorized to promote autonomous motivation, vitality, psychological growth, and well-being, whereas need frustration may contribute to distress and maladjustment (Ryan & Deci, 2020; Ryan et al., 2022). Consequently, the present review examined whether SDT-based interventions reduced psychological symptoms, enhanced positive psychological functioning, or achieved both outcomes. This approach applies the dual-continua model while providing a clearer operational distinction between mental illness and positive mental health (Franken et al., 2018; Westerhof & Keyes, 2010).

A substantial body of research has examined SDT across clinical and non-clinical contexts. However, existing studies vary in their theoretical focus, populations, intervention settings, outcome domains, and methodological designs. These differences make it difficult to draw general conclusions about the effectiveness of SDT-based interventions for mental health. Furthermore, few syntheses have simultaneously considered mental illness and positive mental health while examining the SDT domains, intervention techniques, and contextual factors that may influence intervention effectiveness (Ryan et al., 2022).

1.1 Previous Meta-Analytic Evidence and Research Gaps

Previous meta-analytic evidence can be broadly organized according to Keyes' dual-continua framework. In health-related contexts, Ng et al. (2012) found that autonomy support and satisfaction of the basic psychological needs were associated with favourable health and psychological outcomes. Similarly, Gillison et al. (2019) and Sheeran et al. (2020) reported that SDT-informed interventions improved need satisfaction, autonomous motivation, health-related behaviours, and selected psychological outcomes. However, mental illness outcomes were often secondary outcomes within broader health-behaviour interventions, and several reviews included substantial correlational evidence. Thus, the specific effectiveness of SDT-based interventions for mental illness remains unclear.

Another body of research has focused on positive mental health and psychological functioning. Vite et al. (2024) found that autonomy satisfaction was positively associated with well-being and negatively associated with ill-being among school-aged youth. Similarly, Wang et al. (2024) reported that SDT-based interventions in educational settings improved students' motivation and psychological need satisfaction, while Howard et al. (2024) demonstrated that need-supportive environments were associated with more adaptive functioning and that need-thwarting environments were related to poorer outcomes. Nevertheless, these syntheses largely focused on educational, motivational, or academic outcomes and frequently included correlational evidence. Their findings therefore provide indirect rather than definitive evidence of intervention effects on positive mental health.

Broader syntheses have also supported the applicability of SDT across contexts. Ryan et al. (2022), in a meta-review covering healthcare, education, parenting, organizations, and sport,

concluded that satisfaction of autonomy, competence, and relatedness consistently promotes motivation and well-being, whereas frustration of these needs predicts ill-being and maladjustment. However, the inclusion of diverse populations, study designs, and outcome domains limited the ability of this review to estimate the effects of SDT-based interventions specifically on mental health or to identify the intervention components responsible for positive outcomes.

Several gaps consequently remain. Previous meta-analyses have emphasized health behaviours, motivation, education, or general well-being, while mental health outcomes have received less focused attention. Although the dual-continua model has received considerable empirical support, few reviews have applied it directly to SDT-based interventions by distinguishing mental illness from positive mental health and examining their combined contribution to overall mental health (Iasiello et al., 2020). Moreover, the relative roles of autonomy, competence, relatedness, and intrinsic motivation remain uncertain, as do the effects of specific need-supportive techniques. Limited evidence also exists regarding variation in outcomes according to participant characteristics, cultural context, study design, intervention format, intensity, delivery mode, or provider.

The present systematic review and meta-analysis addresses these limitations by synthesizing experimental and quasi-experimental studies of SDT-based interventions among adolescents and adults. Guided by Keyes' dual-continua model, it evaluates effects on overall mental health while separately examining mental illness and positive mental health outcomes. It also investigates individual SDT domains, need-supportive intervention techniques, and moderators related to participants, methodology, intervention characteristics, and cultural context. Based on SDT and the dual-continua model, it was hypothesized that SDT-based interventions would improve overall mental health by reducing mental illness outcomes and enhancing positive psychological functioning.

The present review makes several contributions to the existing literature. By integrating SDT with Keyes' (2002) dual-continua model, it examines SDT-based interventions across both mental illness and positive mental health (psychological functioning), extending previous syntheses that have largely focused on health behaviours, motivation, or well-being separately (Ng et al., 2012; Ntoumanis et al., 2021; Ryan et al., 2022). It further synthesizes the need-supportive techniques employed across interventions and examines participant, methodological, intervention, and cultural characteristics that may influence intervention effects. These contributions may help clarify the relevance of SDT as a framework for holistic mental health and inform interventions that extend beyond symptom reduction to support positive psychological functioning through autonomy-, competence-, and relatedness-supportive strategies (Ryan & Deci, 2017, 2020; Teixeira et al., 2020). The theoretical and clinical/practical implications of these findings are discussed in greater detail in the Discussion.

2. Methods

2.1 Review Protocol Registration and Reporting Guidelines

The protocol details were deposited in the Open Science Framework (osf.io/4gg6v) through Review Commons that adhered to registered guidelines. The systematic review and meta-analysis was prespecified in PROSPERO (International Prospective Register of Systematic Reviews; CRD420251165636, registered on 20 October 2025). The review followed the methodological advice offered in the Cochrane Handbook for Systematic Reviews of Interventions (version 6.4; Higgins et al., 2023), and reported using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021). All scripts for data extraction, coding manuals, and analytic scripts are available on the Open Science Framework to ensure transparency and replicability.

2.2 Search Strategy

A comprehensive literature search was conducted across ProQuest, PubMed, and Scopus from database inception until the final search date using a predefined search strategy developed in accordance with the review objectives. The search combined controlled vocabulary (where available) and free-text keywords related to SDT, SDT-based interventions, and mental health outcomes. Consistent with Keyes' dual-continua conceptualization of mental health, the search strategy incorporated terms representing both mental illness outcomes (e.g., depression, anxiety, stress, psychological distress, mental disorders) and positive mental health (psychological functioning) outcomes (e.g., psychological well-being, flourishing, resilience, happiness, life satisfaction, and positive mental health).

The complete electronic search strategy for each database is provided in the Supplementary file available through the **Open Science Framework (OSF) repository (File name: Supplementary file)** (https://osf.io/zm29t/overview?view_only=ee16d181b5874da68b4fcc01e3c5b0b7).

2.3 Procedure

The studies were included for full-text review if the intervention was based on SDT, at least one mental health variable was measured, and the participants/ recipients of the therapy were either adolescents (aged 10 and above) (Sawyer et al., 2018) or adults (aged below 60 years). Studies were excluded if the participants were children or the elderly, and if the study design was observational. The screening was conducted with the help of the COVIDENCE software, in which 686 duplicates were removed, and 2203 studies were screened. After the screening, 56 studies were included for full-text review. However, due to insufficient data reported in the article or due to methodological issues where the intervention group and control group were similar, around 13 studies were excluded. The final synthesis consisted of 43 studies after the exclusion (See Figure 1). Screening and data extraction was done by a single

reviewer and later verified by the remaining two reviewers to ensure validity. The disagreements between the two reviewers were resolved through discussions as almost all decisions were unanimous. The reviewer attempted to contact the study authors for more information; however, only one author provided the necessary data, while one author denied access to data due to confidentiality issues, and the remaining authors failed to respond.

Figure 1: PRISMA flow diagram of study selection

(Insert Figure 1 here)

2.4 Data Extraction

A standardized data extraction form was developed to systematically record study characteristics relevant to the objectives of the review. Extracted information included: (a) methodological characteristics (study design, sample size, participant characteristics, control condition, randomization procedures, follow-up duration, and outcome measures); (b) intervention characteristics (setting, intervention provider, delivery mode, intervention format, intervention intensity, duration, and implementation fidelity where reported); and (c) theoretical characteristics (SDT domains targeted, autonomy-, competence-, and relatedness-supportive techniques employed, and other motivational strategies incorporated within the intervention).

The coding framework was initially developed by the corresponding author (N.N.S.) following recommendations from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2023), the meta-analytic procedures described by Lipsey and Wilson (2001), and coding frameworks adopted in previous SDT systematic reviews and meta-analyses (e.g., Teixeira et al., 2020). The framework was subsequently reviewed and refined collaboratively by all authors to ensure conceptual consistency and alignment with the study objectives. The final extraction template was piloted on a subset of eligible studies to assess clarity, feasibility, and inter-rater agreement before full implementation.

All eligible studies were initially coded by the first author (S.P.S.) using the finalized coding framework. Coding decisions were subsequently reviewed by the research team, and any discrepancies were resolved through discussion until consensus was achieved. When essential methodological or statistical information was unavailable, corresponding authors were contacted to obtain clarification or additional data where feasible.

2.5 Quality Assessment

Methodological quality was evaluated using the Revised Cochrane Risk of Bias Tool for Randomized Trials (RoB 2) (Sterne et al., 2019) for randomized controlled trials and the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) (Sterne et al., 2016) for quasi-experimental studies. Risk-of-bias assessments were conducted independently by two reviewers, with disagreements resolved through discussion and consensus.

Risk-of-bias ratings were used to characterize the methodological quality of the included studies and to inform the sensitivity analyses undertaken in the present review. A detailed description of the coding framework, extracted variables, and quality assessment procedures is publicly available through the OSF repository (**File name: Data extraction form; Copy of DATA EXTRACTION SDT META ANALYSIS 2025 (Responses)**). (https://osf.io/zm29t/overview?view_only=ee16d181b5874da68b4fcc01e3c5b0b7).

2.6 Outcome Classification and Data Extraction

To ensure conceptual consistency across the diverse outcome measures reported in the included studies, mental health outcomes were classified *a priori* within Keyes' (2002) dual-continua framework, which conceptualizes mental illness and positive mental health as related but distinct dimensions. Accordingly, outcomes were grouped into two overarching domains: (a) mental illness outcomes, reflecting symptoms of psychopathology and psychological distress, and (b) positive mental health outcomes (positive psychological functioning), reflecting emotional, psychological, and social well-being and related indicators of adaptive functioning (Keyes, 2002; Westerhof & Keyes, 2010). This distinction is also consistent with the broader conceptualization of mental health as extending beyond the absence of mental illness to include well-being and effective functioning (World Health Organization, 2022).

Mental illness outcomes included depression, anxiety, perceived stress, general psychological distress, post-traumatic stress symptoms, and related psychological or behavioural dysfunction. Measures assessing depressive, anxiety, stress, trauma-related, non-specific distress, and broader psychological or behavioural difficulties were classified within this domain according to the primary construct and interpretation of the outcome in the original study (Beck et al., 1988; Kessler et al., 2002; Kroenke et al., 2001; Lovibond & Lovibond, 1995; Radloff, 1977).

Positive mental health (positive psychological functioning) primarily encompassed indicators of emotional, psychological, and social well-being. Core indicators included flourishing, life satisfaction, happiness, positive affect, psychological well-being, and social well-being (Diener et al., 2010; Keyes, 2002; Ryff, 1989; Ryff & Keyes, 1995). Other positively oriented outcomes reported in the included studies—including subjective vitality, hope, meaning in life, self-efficacy, social functioning, and quality of life—were classified within the broader positive psychological functioning domain when they reflected adaptive functioning rather than symptoms of psychopathology. These broader indicators were not considered core components of Keyes' model but were included based on their conceptualization as indicators of positive or adaptive psychological functioning.

Operational definitions of each outcome construct, their classification within the two overarching domains, the psychometric measures used to assess them, and the basis for their classification are provided in Supplementary Table S2.

This classification enabled outcomes assessed using diverse psychometric instruments to be synthesized within a common conceptual framework while preserving the distinction between mental illness and positive mental health. For quantitative synthesis, effect sizes were harmonized so that positive values consistently represented improved mental health, either through reductions in mental illness symptoms or improvements in positive psychological functioning.

2.7 Data Analysis

2.7.1 Narrative Synthesis

Narrative synthesis was undertaken for aspects of the review that were not amenable to quantitative pooling, particularly the characterization of SDT domains, need-supportive intervention techniques, and implementation characteristics across studies. Intervention techniques were synthesized using the Theory Coding Scheme (TCS) (Michie & Prestwich, 2010) to identify the theoretical components employed to support autonomy, competence, relatedness, and intrinsic motivation. In addition, methodological characteristics, intervention features, and implementation strategies associated with SDT-based interventions were descriptively summarized to complement the quantitative findings.

2.7.2 Meta-analysis

Quantitative analyses were performed using Comprehensive Meta-Analysis (CMA) software. A random-effects model was employed to estimate pooled effect sizes, acknowledging the expected heterogeneity arising from differences in participant characteristics, intervention content, and study methodologies. Standardized mean differences (Hedges' g) were calculated to facilitate comparison across studies employing diverse psychometric instruments.

Consistent with Keyes' dual-continua conceptualization of mental health, outcome measures were harmonized such that positive effect sizes uniformly reflected improved mental health. Accordingly, effect sizes derived from mental illness outcomes (e.g., depression, anxiety, stress, psychological distress and etc), where lower scores indicate improvement, were directionally reversed, whereas effect sizes derived from positive mental health (psychological functioning) outcomes (e.g., flourishing, psychological well-being, life satisfaction, subjective vitality, and related constructs), where higher scores indicate improvement, retained their original direction.

Because several studies reported multiple outcome measures assessing the same underlying construct, study-level composite effect sizes were computed to preserve statistical independence and avoid double-counting participants. Combining multiple correlated outcomes into a single synthetic effect size is a recommended meta-analytic approach when outcomes represent the same conceptual construct, as it minimizes unit-of-analysis errors while retaining information from all eligible outcome measures (Borenstein et al., 2021; Higgins et al., 2024). Specifically, all eligible mental illness outcomes reported within an individual study were combined into a single composite effect size representing the mental

illness construct, while all eligible positive mental health (psychological functioning) outcomes were similarly combined into a single composite effect size representing positive mental health. Consequently, each study contributed a maximum of two independent effect sizes (one for mental illness and one for positive mental health) to the primary meta-analysis.

Separate random-effects meta-analyses were subsequently conducted for mental illness outcomes and positive mental health (psychological functioning) outcomes, followed by an overall pooled analysis of the composite effect sizes. Statistical heterogeneity was evaluated using Cochran's Q statistic and prediction intervals. Moderator analyses were performed using the composite dataset to examine participant characteristics (age and country), methodological characteristics (study design), and intervention characteristics (format, delivery mode, and intervention intensity).

As the computation of composite effect sizes aggregated individual psychological constructs into broader mental illness and positive mental health domains, moderator analyses involving SDT domains (autonomy, competence, and relatedness) and intrinsic motivation could not be performed using the composite dataset. Therefore, these theory-driven analyses were conducted separately using the original outcome-level dataset, in which individual outcomes were retained. These analyses were intended to provide theoretical insight into SDT processes and should be interpreted as exploratory rather than definitive estimates of differential intervention effectiveness.

Sensitivity analyses excluding studies with elevated risk of bias were undertaken to examine the robustness of the findings. Publication bias was assessed using Egger's regression test and Duval and Tweedie's trim-and-fill procedure.

3. Results

3.1 Characteristics of Included Studies

Study and Participant Characteristics

The review included 43 intervention studies comprising 23 randomized experimental studies and 20 quasi-experimental studies conducted across schools, community settings, healthcare centres, universities, and other community-based contexts (see Table 1). A total of 7,362 participants were included, of whom 3,693 received SDT-based interventions and 3,669 served as controls. Across studies, 2,948 participants were male and 4,414 were female. The majority of studies were conducted in **Western, Educated, Industrialized, Rich and Democratic (WEIRD; Beyebach et al., 2021) countries (n = 34)**, while nine studies originated from non-WEIRD countries. Participants included both adolescents (11 studies) and adults (31 studies).

(Insert Table 1)

Intervention Characteristics

SDT interventions demonstrated considerable variation in their implementation characteristics (Table 2). Twenty-three interventions were delivered directly by researchers, whereas twenty interventions were delivered by trained professionals, teachers, peers, or facilitators. Twenty studies employed individual formats, twenty-two employed group formats, and one combined both approaches. Most interventions were delivered face-to-face (30 studies), while eleven were delivered online and two adopted blended delivery.

Intervention intensity was categorized as low (<5 sessions), moderate (6–14 sessions), and high (>14 sessions), with 14, 16, and 13 studies falling within these respective categories. Across studies, interventions primarily targeted satisfaction of the three basic psychological needs (autonomy, competence, and relatedness), whereas relatively few interventions focused exclusively on autonomy or intrinsic motivation.

3.2 Narrative Synthesis of SDT Intervention Techniques

To better understand how SDT principles were operationalized, intervention techniques were coded according to the taxonomy proposed by Teixeira et al. (2020) (see Table 2). Across studies, autonomy-supportive techniques most frequently included providing meaningful rationales, offering behavioural choice, and encouraging self-initiation. Competence-supportive strategies commonly involved setting optimal challenges, providing constructive feedback, and facilitating action planning, whereas relatedness-supportive techniques frequently emphasized demonstrating genuine interest, providing ongoing support, and acknowledging participants' perspectives and feelings. These findings indicate that SDT interventions generally targeted multiple psychological needs simultaneously rather than relying on isolated motivational strategies.

(Insert Table 2)

3.3 Meta-analysis of Overall Mental Health Outcomes

A random-effects meta-analysis including 43 studies demonstrated a statistically significant overall effect of SDT-based interventions on mental health, yielding a large pooled effect size ($g = 2.51$, 95% CI 1.83–3.18; see Table 3). Significant heterogeneity was observed (Q test, $p < .001$; $I^2 = 86\%$), with a wide prediction interval (–1.65 to 6.67), indicating substantial variability in intervention effects across studies.

In the present analysis, multiple outcome measures assessing the same underlying construct within individual studies were combined into study-level composite effect sizes for mental illness and positive mental health (psychological functioning), thereby ensuring statistical independence of observations and avoiding double counting of participants. The resulting pooled estimate therefore reflects the overall impact of SDT-based interventions across these two broad domains of mental health rather than across individual psychological outcomes.

(Insert Table 3)

3.4 Subgroup Analyses

To address the primary objectives of the review and consistent with Keyes' dual-continua conceptualization of mental health, subgroup analyses were conducted to examine whether the effects of SDT-based interventions differed across mental health outcome domains, SDT domains, and participant, methodological, and intervention characteristics. The results are presented below.

3.4.1 Outcome Domain (Mental Illness vs. Positive Mental Health [Psychological Functioning])

Separate random-effects meta-analyses were conducted for the two dimensions of mental health proposed by Keyes' dual-continua model, namely mental illness and positive mental health (psychological functioning).

SDT-based interventions demonstrated a large and statistically significant reduction in mental illness outcomes, with a pooled effect size of $g = 2.55$ (95% CI 1.55–3.53) (see Figure 3). This finding reflects substantial improvements in indicators such as depression, anxiety, stress, and psychological distress. However, significant between-study heterogeneity was observed (Q test, $p < .001$; $I^2 = 93\%$; prediction interval = -1.81 to 6.91).

Similarly, SDT-based interventions produced a large and statistically significant improvement in positive mental health (psychological functioning), with a pooled effect size of $g = 2.48$ (95% CI 1.49–3.46) (see Figure 2), reflecting improvements in psychological well-being, flourishing, life satisfaction, subjective vitality, and related constructs. Significant heterogeneity was also observed for this outcome domain (Q test, $p < .001$; $I^2 = 57\%$; prediction interval = -2.27 to 7.23).

Collectively, these findings indicate that SDT-based interventions are associated with substantial improvements in both mental illness outcomes and positive mental health (psychological functioning), supporting the potential of SDT-based approaches to promote holistic mental health across both dimensions of Keyes' dual-continua model.

(Insert Figure 2 and Figure 3 about here)

3.4.2 Participant Characteristics

Moderator analyses were conducted to examine whether participant characteristics influenced the effectiveness of SDT-based interventions. Significant intervention effects were observed among both adolescents ($g = 3.70$, 95% CI 2.22–5.18) and adults ($g = 2.21$, 95% CI 1.42–2.99). However, the between-group comparison was not statistically significant (Q_{between} , $p = .179$), indicating that intervention effectiveness did not differ significantly between adolescent and adult populations (see Table 4).

Similarly, SDT-based interventions demonstrated significant effects in both non-WEIRD countries ($g = 3.43$, 95% CI 1.81–5.05) and WEIRD countries ($g = 2.31$, 95% CI 1.55–3.07).

However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .220$), suggesting that intervention effectiveness was broadly comparable across cultural contexts (see Table 4).

Overall, these findings indicate that participant characteristics, including age group and cultural context, did not significantly moderate the effectiveness of SDT-based interventions in the present review.

3.4.3 Methodological Characteristics

Moderator analyses were conducted to examine whether study design influenced the effectiveness of SDT-based interventions. Significant intervention effects were observed in both randomized experimental studies ($g = 2.97$, 95% CI 2.01–3.92) and quasi-experimental studies ($g = 2.01$, 95% CI 1.01–3.01). However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .178$), indicating that intervention effectiveness did not differ significantly according to study design (see Table 4).

Overall, these findings suggest that SDT-based interventions demonstrated beneficial effects across both randomized experimental and quasi-experimental studies, with no evidence that methodological design significantly moderated the observed intervention effects.

3.4.4 Intervention Characteristics

Moderator analyses were conducted to examine whether intervention intensity, format, and mode of delivery influenced the effectiveness of SDT-based interventions. Significant intervention effects were observed across all levels of intervention intensity, including low-intensity ($g = 2.70$, 95% CI 1.49–3.91), moderate-intensity ($g = 2.24$, 95% CI 1.02–3.45), and high-intensity ($g = 2.64$, 95% CI 1.29–4.02) interventions. However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .850$), indicating that intervention intensity did not significantly moderate intervention effectiveness (see Table 4).

Similarly, significant effects were observed for both group-based interventions ($g = 2.52$, 95% CI 1.56–3.48) and individual interventions ($g = 2.56$, 95% CI 1.57–3.55). The between-group comparison was not statistically significant ($Q_{\text{between}}, p = .789$), suggesting comparable effectiveness across intervention formats. With respect to mode of delivery, both offline interventions ($g = 2.24$, 95% CI 1.41–3.07) and online interventions ($g = 3.27$, 95% CI 2.01–4.53) demonstrated significant intervention effects. However, the between-group comparison was not statistically significant ($Q_{\text{between}}, p = .311$), indicating that intervention effectiveness did not differ significantly according to delivery mode (see Table 4).

Overall, these findings suggest that intervention intensity, format, and delivery mode did not significantly moderate the effectiveness of SDT-based interventions, with beneficial effects observed consistently across implementation characteristics.

3.4.5 SDT Domains (Autonomy, Competence, Relatedness, Motivation)

As the primary meta-analysis was based on study-level composite effect sizes representing mental illness and positive mental health, separate analyses of individual SDT domains could not be performed using the composite dataset. Therefore, to examine the relative contribution of the theoretical constructs underlying SDT, exploratory analyses were conducted using the original outcome-level dataset, in which individual outcomes were retained.

Among the three basic psychological needs, autonomy-supportive interventions demonstrated the largest pooled effect ($g = 1.12$, 95% CI 0.49–1.75). The between-group heterogeneity statistic was statistically significant ($Q_{\text{between}}, p < .001$), indicating variability in effect sizes across autonomy-, competence-, and relatedness-focused interventions (see Table 4). In a separate analysis, interventions targeting intrinsic motivation also demonstrated a statistically significant pooled effect ($g = 0.64$, 95% CI 0.04–1.23), although the heterogeneity statistic was not statistically significant ($Q_{\text{between}}, p = .232$).

Given that these analyses were conducted using the original outcome-level dataset rather than the composite study-level dataset employed in the primary meta-analysis, the findings should be interpreted as exploratory and theory-oriented, providing insight into potential SDT mechanisms rather than definitive evidence regarding the relative importance of individual SDT domains.

(Insert Table 4)

3.6 Risk of Bias Assessment

Risk of bias was evaluated using RoB 2 for randomized studies and ROBINS-I for quasi-experimental studies. Among the randomized studies, ten were judged to have low risk of bias, thirteen raised some concerns, and one was classified as high risk. Among quasi-experimental studies, nine demonstrated moderate risk of bias and ten demonstrated serious risk of bias (see Table 1; Figure 4).

(Insert Figure 4)

3.7 Sensitivity Analysis

As a supplementary robustness analysis, sensitivity analyses were conducted using the original outcome-level dataset by excluding studies with high or serious risk of bias. This analysis yielded a statistically significant pooled effect size ($g = 0.44$, 95% CI 0.12–0.75), while substantial heterogeneity remained (see Table 5). The persistence of a significant intervention effect following the exclusion of studies with elevated risk of bias provides additional support for the robustness of the findings. However, as this analysis was conducted using the original outcome-level dataset rather than the composite study-level dataset employed in the primary meta-analysis, the results should be interpreted as supplementary evidence and not as a direct sensitivity analysis of the primary pooled estimates.

(Insert Table 5)

3.8 Publication Bias

Egger's regression intercept test did not indicate significant publication bias ($p = .321$). Similarly, Duval and Tweedie's trim-and-fill procedure identified no missing studies, with observed and adjusted estimates remaining identical, suggesting minimal evidence of publication bias (see Tables 6–7; Figure 5).

(Insert Table 6 and Table 7) (Insert Figure 5)

4. Discussion

4.1 Summary of Principal Findings

The present systematic review and meta-analysis synthesized evidence from experimental and quasi-experimental studies to evaluate the effectiveness of SDT based interventions on mental health. Guided by Keyes' (2002) dual-continua model of mental health, the review extends previous meta-analytic evidence (Ng et al., 2012; Ryan et al., 2022) by simultaneously examining mental illness outcomes and positive mental health (psychological functioning) within a single evidence synthesis. A principal finding was that SDT-based interventions demonstrated large and statistically significant effects in both reducing mental illness outcomes and enhancing positive mental health (psychological functioning), suggesting that SDT-based interventions may promote holistic mental health through both the alleviation of psychological distress and the enhancement of adaptive psychological functioning (Franken et al., 2018; Westerhof & Keyes, 2010).

Using study-level composite effect sizes to account for multiple correlated outcomes within individual studies, the overall pooled effect of SDT-based interventions on mental health was large and statistically significant. Although substantial between-study heterogeneity remained, moderator analyses did not identify significant differences according to participant characteristics, study design, or intervention characteristics, suggesting that the beneficial effects of SDT-based interventions were broadly consistent across the populations and implementation contexts examined. Exploratory analyses based on the original outcome-level dataset indicated comparatively larger effect sizes for autonomy-supportive interventions, while autonomy-, competence-, and relatedness-supportive techniques were commonly represented across successful interventions. However, these findings should be interpreted cautiously given their exploratory nature and the substantial heterogeneity observed across studies (Gillison et al., 2019; Ntoumanis et al., 2021; Sheeran et al., 2020).

Collectively, the findings support SDT as a theoretically grounded framework for promoting holistic mental health by simultaneously reducing psychopathology and fostering positive psychological functioning, consistent with the dual-continua conceptualization of mental health (Keyes, 2002; Ryan & Deci, 2020; Westerhof & Keyes, 2010).

4.2 Mental Illness and Positive Mental Health (Psychological Functioning): A Dual-Continua Perspective

A major contribution of the present review is the separate quantitative synthesis of mental illness outcomes and positive mental health (psychological functioning) outcomes within Keyes' (2002) dual-continua framework of mental health. Unlike traditional conceptualizations that define mental health merely as the absence of psychopathology, the dual-continua model proposes that mental illness and positive mental health represent related but distinct dimensions, such that reductions in psychological symptoms do not necessarily imply the presence of flourishing or optimal psychological functioning (Keyes, 2002; Keyes, 2005; Westerhof & Keyes, 2010). Consistent with this theoretical perspective, the present review demonstrated that SDT-based interventions were associated with large and statistically significant improvements in both mental illness outcomes and positive mental health (psychological functioning), suggesting that these interventions may simultaneously facilitate recovery from psychological distress while promoting adaptive psychological functioning (Franken et al., 2018; Iasiello et al., 2020).

These findings are consistent with SDT, which proposes that the satisfaction of the basic psychological needs for autonomy, competence, and relatedness fosters autonomous motivation, psychological integration, and optimal functioning (Deci & Ryan, 2000; Ryan & Deci, 2017, 2020). Need-supportive environments are theorized to buffer individuals against psychological distress while simultaneously promoting vitality, personal growth, psychological well-being, and flourishing (Ryan et al., 2022; Vansteenkiste et al., 2020). The present findings therefore provide empirical support for the proposition that SDT-based interventions may influence mental health through both illness reduction and the promotion of positive psychological functioning, rather than exclusively targeting symptom alleviation (Ntoumanis et al., 2021; Ryan et al., 2022).

The present review also extends previous SDT meta-analyses, which have primarily focused on health behaviours, motivation, or well-being in isolation (Ng et al., 2012; Ryan et al., 2022). By integrating mental illness outcomes and positive mental health (psychological functioning) outcomes within a single evidence synthesis using study-level composite effect sizes, the present review provides a broader evaluation of the potential mental health benefits of SDT-based interventions while avoiding dependence among multiple outcomes reported within individual studies. This approach offers a theoretically coherent framework for understanding how SDT-informed interventions may contribute to holistic mental health, encompassing both the reduction of psychopathology and the enhancement of positive psychological functioning (Franken et al., 2018; Iasiello et al., 2020).

The findings further resonate with recovery-oriented models of mental health, which emphasize that recovery extends beyond symptom remission to include the development of meaningful, satisfying, and socially connected lives despite the presence or history of mental illness (Slade, 2010; Slade et al., 2014, 2015). Collectively, the present findings provide quantitative support for the application of Keyes' dual-continua model as a useful conceptual framework for evaluating mental health interventions and suggest that SDT-based interventions may offer a promising approach for simultaneously reducing psychological distress and promoting flourishing across clinical and non-clinical populations (Iasiello et al., 2020; Westerhof & Keyes, 2010).

4.3 SDT Domains: Autonomy, Competence, Relatedness, and Motivation

Subgroup analyses indicated that interventions emphasizing autonomy demonstrated comparatively larger effect sizes on mental health outcomes, although all SDT domains contributed positively to intervention effectiveness. This finding is consistent with Self-Determination Theory, which identifies autonomy as a central psychological need underlying autonomous motivation and sustained behavioural change (Deci & Ryan, 2000; Ryan & Deci, 2017). Autonomy-supportive environments may enhance self-endorsed behaviour, engagement, and adaptive emotion regulation, thereby contributing to improvements in both mental illness outcomes and positive mental health (Ryan & Deci, 2020; Teixeira et al., 2020). The significant effects observed for motivation further reinforce previous evidence linking autonomous motivation with psychological well-being and adaptive functioning (Howard et al., 2021; Ryan et al., 2022).

Importantly, autonomy support within SDT should not be interpreted as the absence of guidance or external structure. Rather, autonomy-supportive approaches can appropriately incorporate scaffolding, competence-enhancing feedback, co-regulation, and graduated decision-making support, particularly for individuals experiencing severe psychological distress or impaired executive functioning (Ryan & Deci, 2017; Teixeira et al., 2020). Thus, autonomy support is best conceptualized as facilitating volitional functioning within a structured and supportive interpersonal context, rather than promoting unrestricted independence (Soenens et al., 2007; Vansteenkiste et al., 2012). Consistent with SDT, autonomy, competence, and relatedness should therefore be viewed as complementary psychological needs, suggesting that interventions integrating support for all three needs are likely to provide the greatest potential for promoting holistic mental health (Deci & Ryan, 2000; Vansteenkiste et al., 2020).

4.4 Need-Supportive Intervention Techniques

The narrative synthesis demonstrated that successful SDT-based interventions consistently incorporated autonomy-, competence-, and relatedness-supportive techniques, although their implementation varied across settings and populations. Frequently identified strategies included providing meaningful rationales, offering behavioural choice, encouraging self-initiation, facilitating optimal challenge, providing constructive feedback, and fostering empathic and supportive interpersonal relationships. These techniques closely reflect the need-supportive strategies proposed within SDT (Deci & Ryan, 2000; Teixeira et al., 2020) and are theorized to facilitate the internalization of autonomous motivation. Rather than relying on isolated techniques, most interventions combined multiple need-supportive components, suggesting that their synergistic application may underlie improvements in both mental illness outcomes and positive psychological functioning (Gillison et al., 2019; Ntoumanis et al., 2021). The present synthesis therefore provides practical guidance for designing SDT-informed interventions that translate motivational theory into evidence-based mental health practice.

4.5 Moderator Findings

The present review did not identify statistically significant moderator effects for participant characteristics, methodological characteristics, or intervention characteristics. Significant intervention effects were observed across all examined subgroups, suggesting that the benefits of SDT-based interventions were broadly consistent across diverse populations and implementation contexts. This finding is consistent with SDT, which proposes that the basic psychological needs for autonomy, competence, and relatedness represent universal psychological processes that facilitate optimal functioning across developmental stages and cultures (Deci & Ryan, 2000; Ryan & Deci, 2017; Vansteenkiste et al., 2020).

Although numerical differences in effect sizes were observed across subgroups, the absence of statistically significant between-group differences suggests that these variations should be interpreted cautiously and are likely attributable to sampling variability or residual heterogeneity rather than systematic differences in intervention effectiveness (Cuijpers et al., 2021; Higgins et al., 2022). Importantly, a non-significant subgroup test does not establish that subgroup effects are identical; subgroup analyses may have limited statistical power, particularly when the number of studies is small or the subgroups are unevenly represented (Cuijpers et al., 2021). Similar observations have been reported in previous SDT meta-analyses (Ng et al., 2012; Ryan et al., 2022). Future studies employing standardized intervention protocols and larger evidence bases are needed to identify additional moderators that may explain the remaining heterogeneity and optimize SDT-based interventions across clinical and non-clinical populations.

4.6 Theoretical Implications

The present findings extend the SDT literature by integrating Keyes' (2002) dual-continua model of mental health with Self-Determination Theory. Whereas previous SDT meta-analyses have largely focused on health behaviours, motivation, or well-being in isolation (Ng et al., 2012; Ntoumanis et al., 2021; Ryan et al., 2022), the present review demonstrates that SDT-based interventions are associated with both reductions in mental illness outcomes and improvements in positive mental health (psychological functioning). These findings are consistent with SDT, which proposes that satisfaction of the basic psychological needs for autonomy, competence, and relatedness facilitates not only the prevention of psychological distress but also psychological growth and flourishing (Deci & Ryan, 2000; Ryan & Deci, 2017, 2020). By synthesizing both dimensions of mental health within a single evidence synthesis, the present review supports SDT as a comprehensive theoretical framework for understanding and promoting holistic mental health (Iasiello et al., 2020; Westerhof & Keyes, 2010).

4.7 Clinical and Practical Implications

The present findings have important implications for the development of motivation-based mental health interventions. Consistent with Keyes' (2002) dual-continua model, SDT-based interventions may contribute to both the reduction of psychological distress and the enhancement of positive mental health (psychological functioning), thereby extending intervention goals beyond symptom reduction alone (Franken et al., 2018; Slade, 2010).

Incorporating autonomy-supportive communication, competence-enhancing feedback, and opportunities for meaningful interpersonal connection may complement existing evidence-based psychological interventions by promoting both recovery and psychological flourishing (Ryan & Deci, 2017; Teixeira et al., 2020). Given the broad applicability of SDT principles across healthcare, educational, organizational, and community settings, SDT-informed interventions may provide a useful framework for developing scalable mental health promotion programs that integrate symptom management with the promotion of positive psychological functioning and well-being (Gillison et al., 2019; Ntoumanis et al., 2021; Ryan et al., 2022).

4.8 Strengths and Limitations

The present review has several notable strengths. It was conducted in accordance with the Cochrane Handbook and PRISMA 2020 guidelines and was prospectively registered in PROSPERO, enhancing methodological transparency and reducing reporting bias. A comprehensive literature search, predefined eligibility criteria, standardized data extraction procedures, and systematic assessment of study quality using RoB 2 and ROBINS-I strengthened the methodological rigor of the review. Publication bias and sensitivity analyses were undertaken to examine the robustness of the findings. A further strength was the computation of study-level composite effect sizes for mental illness and positive mental health outcomes, which minimized dependence among multiple outcomes reported within individual studies while preserving the conceptual distinction proposed by Keyes' dual-continua model. The integration of quantitative meta-analysis with narrative synthesis also enabled the identification of commonly employed SDT-based intervention techniques and their potential theoretical relevance.

Nevertheless, several limitations should be acknowledged. Substantial between-study heterogeneity remained across analyses, suggesting that the pooled estimates should be interpreted as average effects across diverse populations, interventions, and outcome measures rather than precise estimates of intervention efficacy. Considerable variability in intervention content, implementation characteristics, and outcome measures may have contributed to this heterogeneity. Furthermore, the SDT-domain analyses (autonomy, competence, relatedness, and motivation) were conducted using the original outcome-level dataset and should therefore be interpreted as exploratory rather than definitive. Finally, because most interventions simultaneously incorporated multiple autonomy-, competence-, and relatedness-supportive techniques, the present review was unable to isolate the independent contribution of individual intervention components, and restricting the review to English-language publications may have introduced language bias.

4.9 Future Directions

Future research should prioritize methodologically rigorous randomized controlled trials employing standardized SDT-based intervention protocols and longer follow-up periods to evaluate the durability of intervention effects. Studies should simultaneously assess mental illness outcomes and positive mental health (psychological functioning) to better reflect the

dual-continua conceptualization of mental health, while reporting participant characteristics such as baseline symptom severity, motivational readiness, and psychological need satisfaction more consistently to facilitate moderator analyses. Future investigations should also seek to identify the active intervention ingredients underlying SDT-based interventions through dismantling studies, factorial designs, or component network meta-analyses, thereby clarifying the relative contribution of autonomy-, competence-, and relatedness-supportive techniques across diverse populations and cultural contexts.

4.10 Conclusion

The present systematic review and meta-analysis suggests that SDT based interventions may promote holistic mental health by simultaneously reducing mental illness outcomes and enhancing positive mental health (psychological functioning). By synthesizing evidence within Keyes' dual-continua model of mental health, the review extends previous SDT evidence syntheses that have largely examined symptom reduction or well-being in isolation and provides a more comprehensive understanding of the potential mental health benefits of SDT-based interventions. Despite substantial between-study heterogeneity, the findings indicate that SDT-based interventions may offer a promising motivation-based framework for promoting both recovery from psychological distress and the enhancement of positive psychological functioning across diverse populations and settings. Future methodologically rigorous trials employing standardized intervention protocols and longer follow-up assessments are needed to clarify the mechanisms underlying these effects and to optimize the implementation of SDT-based interventions in clinical and non-clinical contexts.

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APPENDICES

Table 1: Summary of included studies

Sl N o.	Author(s)	Year	Study Design	Sample	Country	SDT domains	Outcomes	Risk of Bias
1.	Latre-Navarro, Quintas-Hijós, & Sáez-Bondía	2024	Quasi-experimental	Adult	Spain	BPN Autonomy; Competence; Relatedness	Increased BPN in the intervention group; Time x interaction effects found for autonomy and competence; Favours intervention	Moderate
2	McMahon & Hanrahan	2020	Experimental	Adolescent	Australia	BPN	Reduced social anxiety; Increased relatedness; Favours intervention	Some concerns
3	Walters et al.	2023	Quasi-experimental	Adolescent	USA	BPN	Increased body esteem; Favours intervention	Moderate
4	Zhu et al.	2025	Quasi-experimental	Adult	Netherlands	Autonomy Competence Relatedness Autonomous motivation	Greater enjoyment and increased value of the curriculum; Favours intervention	Moderate
5	Schaper et al.	2022	Experimental	Adult	Germany	Autonomy Competence Relatedness Intrinsic motivation Identified motivation Extrinsic motivation BPN	Increased autonomy; No effect on e-learning; Favours control group	Low
6	Behzadnia & FatahModares	2023	Experimental	Adult	Iraq	BPN	Increases need satisfaction, mindfulness and vitality; Reduced need- frustration, illness-anxiety and test anxiety; Favours intervention	Some concerns
7	Kiltz, Fokkens-Bruinsma & Jansen	2024	Quasi-experimental	Adult	Netherlands	Need Satisfaction and need frustration of Autonomy, competence, and relatedness	Competence linked with well-being and resilience; No significant effect of the intervention	Serious
8	Jang & Reeve	2021	Experimental	Both	Philippines	Intrinsic goal Autonomy Need satisfaction	Intrinsic goals linked with autonomy support and increased need satisfaction and teaching efficacy; Favours intervention	Some concerns

9	Van Hoecke et al.	2014	Experimental	Adult	Belgium	BPN	Increased physical well-being, non-significant increase in psychological well-being; Favours intervention	Moderate
10	Vanroy et al.	2017	Quasi-experimental	Adult	Belgium	BPN	No significant effect of the intervention	Serious
11	Conesa et al.	2023	Quasi-experimental	Adolescent	Spain	Autonomy Competence Relatedness Autonomous motivation	Increased students' autonomy, competence, autonomous motivation, and engagement. Favours intervention	Moderate
12	Tock et al.	2024	Experimental	Adult	Canada	BPN Autonomy Competence Relatedness	Increased psychological need satisfaction, quality of life and exercise motivation Favours intervention	Low
13	Triebner et al.	2024	Experimental	Adult	Germany	Autonomous motivation Controlled motivation Intrinsic motivation	Increased intrinsic motivation, autonomy. Reduced stress; Motivation mediated stress reduction; Favours intervention	Low
14	Nelson et al.	2015	Experimental	Adult	USA and South Korea	Autonomy	Increased well-being Increased well-being mediated by BPN Favours intervention	Low
15	Cheon et al.	2014	Experimental	Adolescent	South Korea	Autonomy support BPN	Increased motivation and well-being Favours intervention	Low
16	Lamoneda Prieto et al.	2024	Quasi-experimental	Adult	Spain	Autonomy Competence Relatedness	Improved autonomy Favours intervention	Serious
17	Emond Pelletier & Joussemet	2017	Experimental	Adult	Canada	Autonomy Competence Relatedness	Increased autonomy, value, and engagement. Reduced anxiety Favours intervention	Low
18	Farah & Nicole	2016	Experimental	Adult	Jordan	Need frustration	Reduced depressive symptoms and stress Favours intervention	Some concerns
19	Hooker et al.	2024	Quasi-experimental	Adult	USA	Autonomy Competence Relatedness Intrinsic motivation Identified motivation Integrated motivation	Increased autonomy, competence and meaning salience Favours intervention	Serious
20	Oram, Dou, & Rogers	2022	Experimental	Adult	Canada	BPN Autonomy Competence	Increased BPN satisfaction Favours intervention	High

						Relatedness Autonomous motivation		
21	Wang, Hu, & Guo Study 1	2013	Experimental	Adolescent	China	Autonomy	Intrinsic goal setting was linked with better test performance and reduced test anxiety Favors intervention	Low
22	Wang, Hu, & Guo Study 2	2013	Experimental	Adolescent	China	Autonomy	Intrinsic goal setting had better test performance and reduced anxiety Favors intervention	Low
23	Ruf et al.	2024	Experimental	Adult	Austria	BPN	No significant effect on the psychological variables Did not favour intervention	Some concerns
24	Chemtob et al.	2019	Experimental	Adult	Canada	BPN Autonomous motivation	Increased autonomous motivation Favours the intervention	Some concerns
25	Pang & Woerkom	2025	Quasi-experimental	Adult	Switzerland	BPN	Reduced negative affect and perceived stress Favours intervention	Some concerns
26	Keeler et al. Study 1	2021	Quasi-experimental	Adult	USA	Autonomy Competence Relatedness	Reduced depression Favours intervention	Serious
27	Keeler et al. Study 2	2021	Quasi-experimental	Adult	USA	BPN	Reduced depression and distress Favours intervention	Serious
28	Fakieh Alrabai & Wala Algazzaz	2024	Quasi-experimental	Adult	Saudi Arabia	BPN	Increased BPN satisfaction and emotional engagement Favours intervention	Low
29	Behzadnia & FatahModares	2020	Experimental	Adult	Iran	Need satisfaction Need frustration Autonomous motivation	Increased need satisfaction, autonomous motivation, vitality Reduced need frustration, amotivation and perceived Favors intervention	Some concerns
30	Ha, Lonsdale, Lubans, & Ng	2020	Experimental	Adolescent	Hong Kong	Autonomy Competence Relatedness Autonomous motivation	Increased physical activity Stronger interventional effects for females with respect to autonomy, competence, and motivation Favours intervention	Low
31	Vella-Brodrick, Chin, & Rickard	2020	Quasi-experimental	Adolescent	Australia	Autonomy Competence Relatedness	Increased autonomy, competence, relatedness Favours intervention	Serious

32	Weigensberg et al.	2018	Quasi-experimental	Adult	USA	BPN	Reduced perceived stress and depression Increased well-being Favours intervention	Serious
33	Manzano-Sánchez et al.	2019	Quasi-experimental	Adolescent	Spain	Intrinsic motivation Extrinsic motivation Autonomy Competence Relatedness BPN	Increased personal responsibility Increased BPN and intrinsic motivation in females Favours intervention	Moderate
34	Hooker, Masters, & Ranby	2020	Experimental	Adult	USA	BPN	No significant effect on SDT constructs Did not favour the intervention	Some concerns
35	Park et al.	2020	Quasi-experimental	Adult	New Zealand	BPN	Increased well-being Reduced problematic gaming Favours the intervention	Serious
36	Shannon et al.	2019	Quasi-experimental	Adult	Ireland	Competence	Increased competence, mindful awareness and well-being Reduced stress Favours intervention	Low
37	Gradito Dubord et al.	2022	Quasi-experimental	Adult	Canada and France	Need satisfaction Need frustration Autonomous motivation Controlled motivation	Increased strength use, need satisfaction, autonomous motivation and psychological well-being Increased need satisfaction led to increased motivation, which resulted in increased well-being Favours the intervention	Serious
38	Sagaribay	2024	Experimental	Adult	USA	Autonomy Competence Relatedness	No changes in BPN Improved depression, anxiety, stress and body image satisfaction Favours the intervention	Some concerns
39	Robinson	2024	Experimental	Adult	USA	Autonomy Competence Relatedness BPN	Negative correlation between PTSD and SDT constructs Did not favour the intervention	Some concerns
40	Ataşalar	2017	Quasi-experimental	Adolescent	Turkey	BPN	Increased need satisfaction, but overall, no effects on other variables Did not favour the intervention	Moderate
41	Alvarez	2015	Quasi-experimental	Adult	USA	Autonomy Competence	Increased intrinsic regulation Did not favour the intervention	Serious

						Relatedness External Introjected Identified Intrinsic		
42	Chiu	2022	Experimental	Adult	Hong Kong	Perceived autonomy Perceived competence Perceived relatedness	Increased need satisfaction led to high-quality teaching practices integrated with technology	Some concerns
43	White, Lubans, & Eather	2022	Experimental	Adolescent	Australia	BPN	High levels of satisfaction and adherence. Medium positive effects on mental health and social health. Favours the intervention	Some concerns

Note: The reference list for Table 1 is available in supplementary file.. (https://osf.io/zm29t/overview?view_only=ee16d181b5874da68b4fcc01e3c5b0b7).

Table 2: Techniques used to address BPN

SDT Domain	Specific Techniques	Operationalized as	No. of studies using them	% of studies	References
Autonomy	A1. Elicit perspectives on condition or behaviour	Discussing about own opinions regarding the behaviour to be changed	9	20.93%	S14, S15, S19, S20, S23, S35, S36, S37, S43
	A2. Prompt identification of sources of pressure for behaviour change	Identifying various behaviours and reasons to change current behaviour to target behaviour	16	37.21%	S3, S12, S13, S15, S16, S18, S21, S22, S23, S26, S27, S31, S35, S38, S41, S42
	A3. Use non-controlling, informational language	Making the language more informative and suggestive by using words like 'may', 'can', etc	16	37.21%	S6, S8, S9, S10, S11, S15, S16, S17, S20, S21, S22, S28, S30, S33, S36, S40
	A4. Explore life aspirations and values	Enquire about current values regarding target behaviour and life goals.	9	20.93%	S4, S8, S12, S18, S20, S21, S22, S24, S39
	A5. Provide a meaningful rationale	Explain the need for change and the need to attend the intervention	20	46.51%	S1, S6, S7, S9, S11, S13, S14, S15, S17, S18, S19, S21, S22, S23, S24, S30, S31, S34, S39, S40
	A6. Provide choice	Giving a few exercises and asking to choose one. Choice to perform any one task from a list of tasks on a given day.	24	55.81%	S1, S3, S4, S5, S6, S8, S9, S11, S12, S13, S14, S15, S16, S17, S19, S21, S22, S23, S24, S26, S27, S29, S40, S41, S42, S43
	A7. Encourage the person to experiment and self-initiate the behaviour	Individually engaging in a task, self-paced and self-timed homework	21	48.84%	S3, S4, S6, S7, S8, S10, S11, S13, S16, S21, S22, S29, S31, S32, S34, S35, S37, S38, S39, S42
Competence	C1. Address obstacles to change	After engaging in a behaviour, explore barriers to achieving the target behaviour with the help of experts.	15	34.88%	S2, S4, S9, S12, S18, S19, S20, S26, S27, S31, S33, S36, S38, S41, S43
	C2. Clarify expectations	Before engaging in a target behaviour, set realistic goals and timelines to achieve them	14	32.56%	S4, S6, S7, S9, S16, S20, S23, S25, S28, S33, S38, S40, S42, S43
	C3. Assist in setting optimal challenge	The expert gradually increases the difficulty of tasks to achieve the target behaviour based on the performance	26	60.47%	S2, S3, S6, S7, S8, S9, S10, S12, S13, S15, S16, S17, S18, S19, S20, S24, S25, S26, S27, S30, S31, S33, S39, S41, S42, S43

	C4. Offer constructive, clear, and relevant feedback	Discuss and offer feedback on how to improve and maintain the performance	18	41.86%	S1, S4, S5, S7, S9, S11, S12, S13, S16, S20, S24, S26, S27, S30, S35, S36, S40, S41
	C5. Help develop a clear and concrete plan of action	The overall list of tasks expected to be completed to attain the target behaviour is shared	17	39.53%	S1, S3, S9, S10, S12, S15, S18, S23, S25, S31, S34, S35, S36, S38, S39, S40, S42
	C6. Promote self-monitoring	Enable the participant to self-monitor the progress by pre-specifying the deadlines	12	27.91%	S1, S6, S11, S13, S19, S24, S29, S30, S32, S34, S35, S38
	C7. Explore ways of dealing with pressure	Teach how to effectively manage time	5	11.63%	S2, S32, S33, S36, S43
Relatedness	R1. Acknowledge and respect perspectives and feelings	Engage in conversations with peers and partners engaging in the same task	17	39.53%	S1, S2, S6, S8, S9, S13, S15, S18, S20, S23, S24, S33, S36, S37, S39, S40, S43
	R2. Encourage asking of questions	Questions to reflect on the current progress	14	32.56%	S4, S7, S9, S13, S9, S13, S15, S23, S26, S27, S28, S30, S31, S35
	R3. Show unconditional regard	Give positive feedback on efforts taken	5	11.63%	S9, S14, S18, S37, S43
	R4. Demonstrate/show interest in the person	Individually ask for lived experiences related to the target behaviour	18	41.86%	S2, S5, S6, S8, S9, S10, S13, S14, S15, S16, S18, S32, S35, S37, S38, S39, S40, S43
	R5. Use empathic listening	Communicate empathetically verbally and non-verbally	13	30.23%	S2, S5, S9, S15, S17, S20, S24, S28, S30, S32, S33, S37, S40
	R6. Providing opportunities for ongoing support	Peer support in groups	18	41.86%	S1, S3, S10, S12, S13, S14, S16, S22, S25, S26, S27, S29, S31, S32, S35, S38, S41, S42
	R7. Prompt identification and seek available social support	Peer support, referral system and appointment with experts	13	30.23%	S2, S3, S24, S26, S27, S29, S31, S32, S34, S38, S41, S42, S43

*A1-A7, C1-C7, R1-R7 refer to unique serial numbers given to each technique

*S1-S43 refers to Study 1- Study 43 corresponding to serial numbers in Table 1

Table 3: Meta-analysis of the overall effectiveness of SDT-based interventions in the mental health domain

Mean effect size	Std error	Variance	Confidence interval	Z value	p value	Prediction interval	Q value	p value	I square
								(Q)	
2.511	0.345	0.119	1.83 3.18	7.28	0.001	-1.64 6.67	460.047	0.001	86%

Table 4: Subgroup Analyses

Variables	Mean effect size	Std error	Variance	Confidence interval	Z value	p value	Prediction interval	Q value TOTAL BETWEEN	p-value (Q)
BPN									
Autonomy	1.12	0.32	0.10	0.49 1.75	3.49	0.001	-2.42 4.67	27.71	0.001
Motivation	0.64	0.30	0.09	0.04 1.23	2.11	0.035	-2.89 4.17	1.43	0.232
Mental health indicators									
Mental Illness	2.54	0.50	0.25	1.55 3.53	5.05	0.001	-1.81 6.91	372.93	0.001
Positive Mental Health	2.48	0.47	0.22	1.49 3.46	4.94	0.001	-2.27 7.23	86.74	0.001

Age

Adolescent	3.71	0.75	0.56	2.22	4.91	0.001	-0.8	3.44	0.179
				5.18					
Adult	2.21	0.40	0.16	1.42	5.50	0.001	-2.11		
				2.99					

Country

Non-WEIRD	3.43	0.82	0.68	1.81	4.14	0.001	-1.11	1.50	0.220
				5.05					
WEIRD	2.31	0.38	0.15	1.55	5.95	0.001	-1.99		
				3.07					

Study design

Experimental	2.97	0.48	0.23	2.01	6.07	0.001	-1.40	1.81	0.178
				3.92					
Quasi-experimental	2.01	0.51	0.26	1.01	3.95	0.001	-2.36		
				3.01					

Format of therapy

Group	2.52	0.48	0.23	1.56	5.15	0.001	-1.77	0.47	0.789
				3.48					
Individual	2.56	0.50	0.25	1.57	5.06	0.001	-1.74		
				3.55					

Intensity									
Low	2.70	0.61	0.38	1.49	4.36	0.001	-2.05		0.851
				3.91					
Moderate	2.24	0.62	0.38	1.02	3.61	0.001	-2.52	0.322	
				3.45					
High	2.64	0.69	0.47	-1.29	3.83	0.001	-2.15		
				4.00					
Delivery mode									
Offline	2.24	0.42	0.17	1.41	5.31	0.001	-2.02	2.33	0.311
				3.07					
Online	3.27	0.64	0.41	2.01	5.07	0.001	-1.11		
				4.53					

Table 5: Sensitivity analysis

Mean effect size (before)	Mean effect size (after)	Std error	Variance	Confidence interval	Z value	p value	Prediction interval	Q value	p value (Q)	I square
0.30	0.44	0.16	0.03	0.12	2.72	0.006	-3.53	20119.96	0.001	99.22
				0.75			4.40			

Table 6: Egger's Regression Intercept

Intercept	Standard Error	Upper Limit	Lower Limit	t-value	p-value (2-tailed)	p-value (1-tailed)
1.35	1.36	-1.33	4.04	0.99	0.32	0.16

Table 7: Duval and Tweedie's Trim and Fill (Random effects Model)

	Point Estimate	Lower Limit	Upper Limit	Q statistic
Observed	0.30	0.73	0.54	20423.42
Adjusted	0.30	0.73	0.54	20423.42

Figure 1: PRISMA flow diagram of study selection

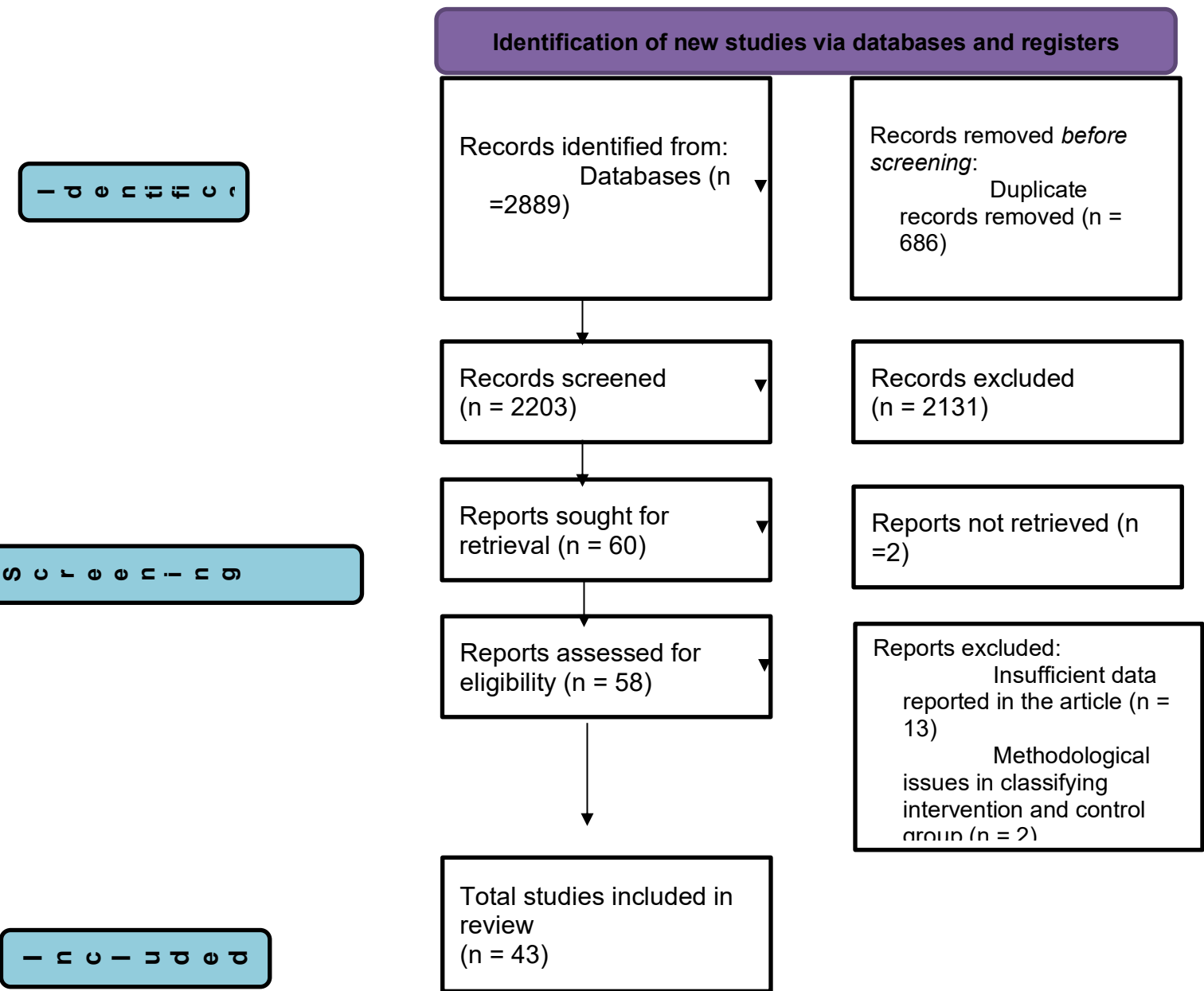


Figure 2: Forest plot of the pooled effect of SDT-based interventions on positive-mental health

Positive Mental Health forest plot

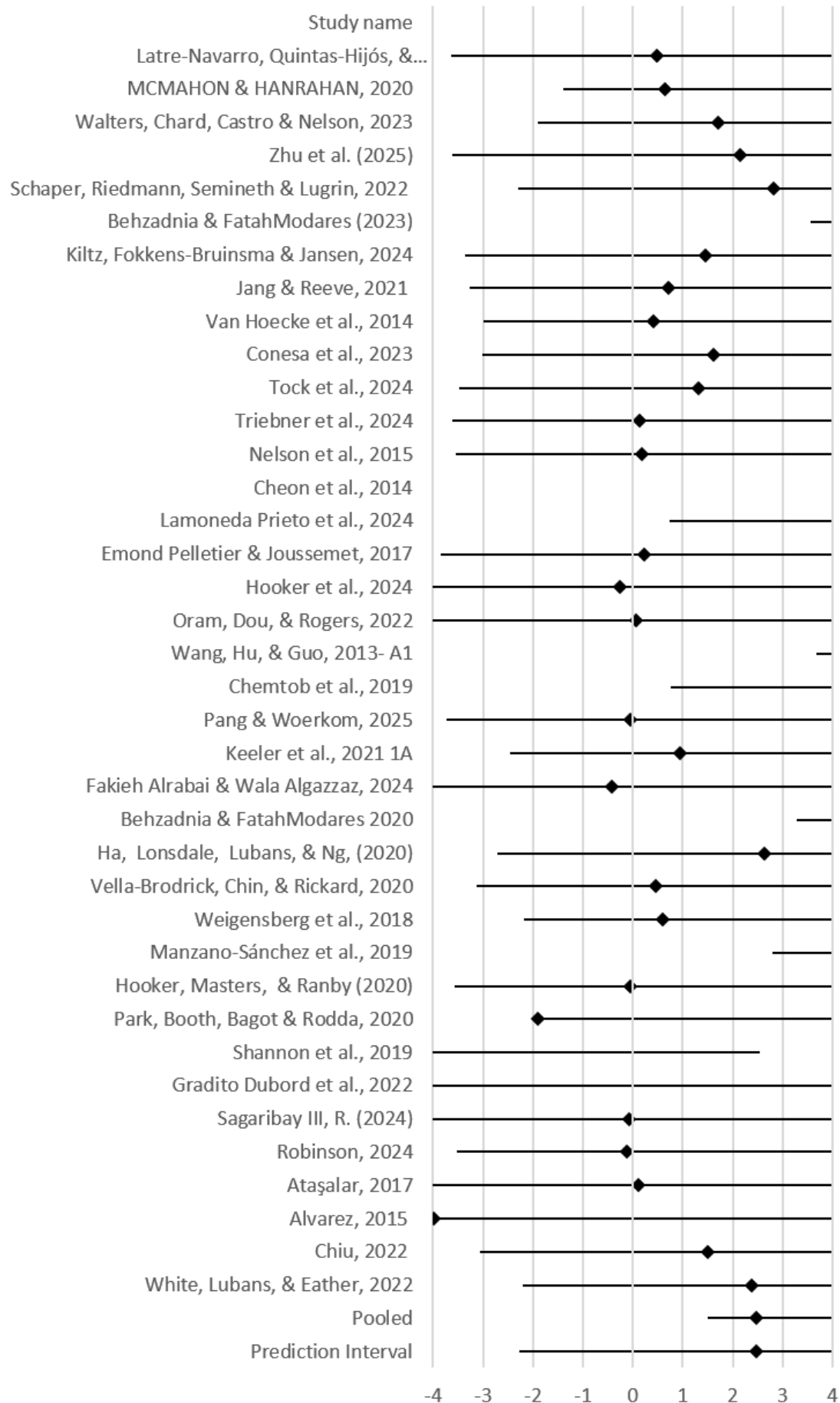


Figure 3: Forest plot of the pooled effect of SDT-based interventions on mental illness outcomes

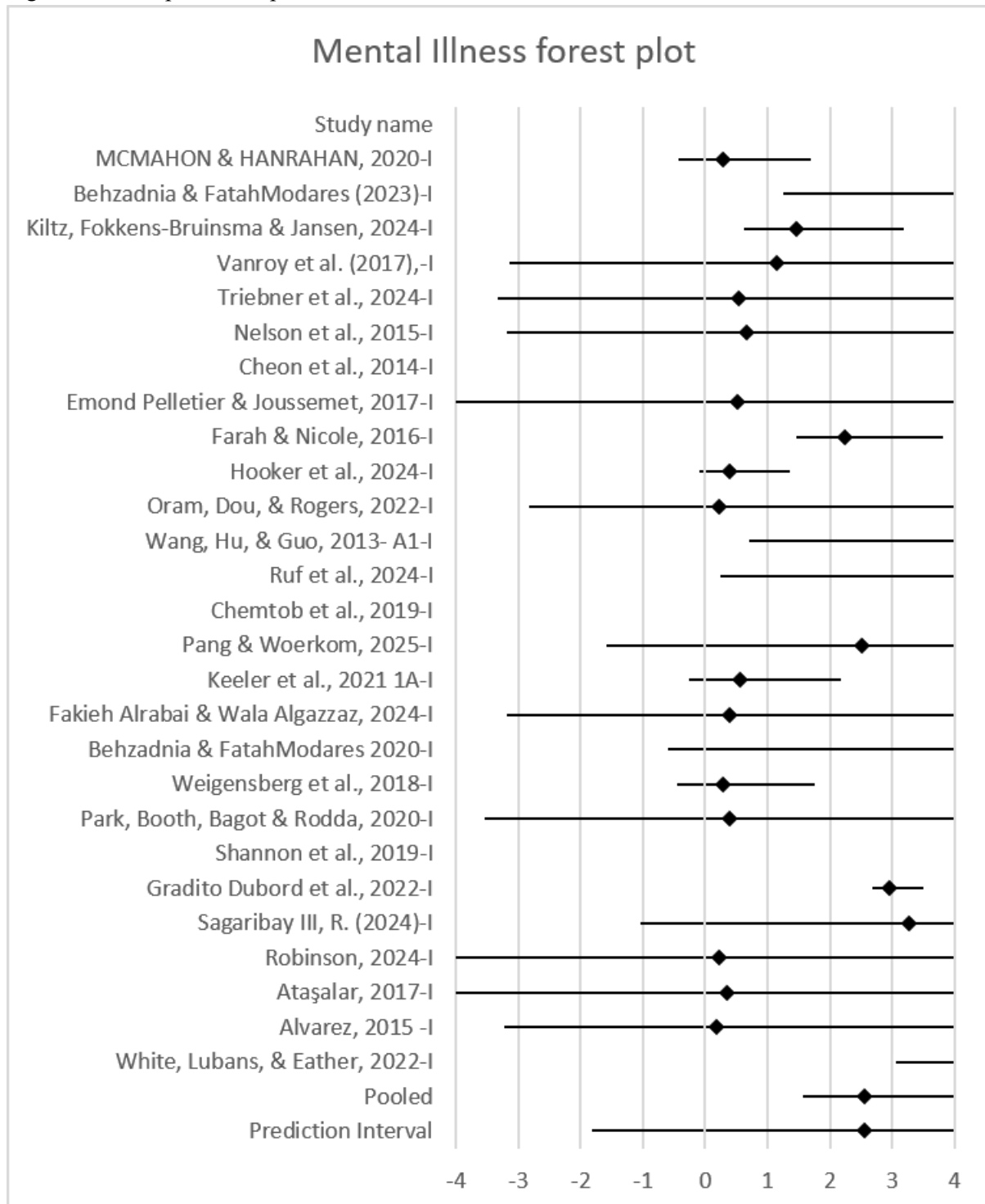


Figure 4: Risk of bias assessment of the included studies.

	Risk of bias domains				
	D1	D2	D3	D4	D5
Tock et al.,2024					
Triebner et al.,2024					
Nelson et al.,2015					
Cheon et al.,2014					
Emond Pelletier & Joussemet, 2017					
Farah & Nicole, 2016					
Oram, Dou, & Rogers, 2022					
Wang, Hu, & Guo, 2013					
Ruf et al., 2024)					
Chemtob et al., 2019					
Pang & Woerkom, 2025					
Behzadnia & FatahModares, 2020					
Sagaribay III, R. (2024)					
Robinson, 2024					
Chiu, 2022					
White, Lubans, & Eather, 2022					
McMahon & Stephanie J. Hanrahan (2020)					
9.Schaper, Riedmann, Semineth & Lugin, 2022					
Behzadnia & FatahModares (2023)					
53.Ha, Lonsdale, Lubans, & Ng, (2020)					
51.Hooker, Masters, & Ranby (2020))					

Study

Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
 High
 Some concerns
 Low

Figure 5: Funnel plot for assessment of publication bias.

